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TECHNICAL MANUAL

for

OSCILLOSCOPE AN/USM-281

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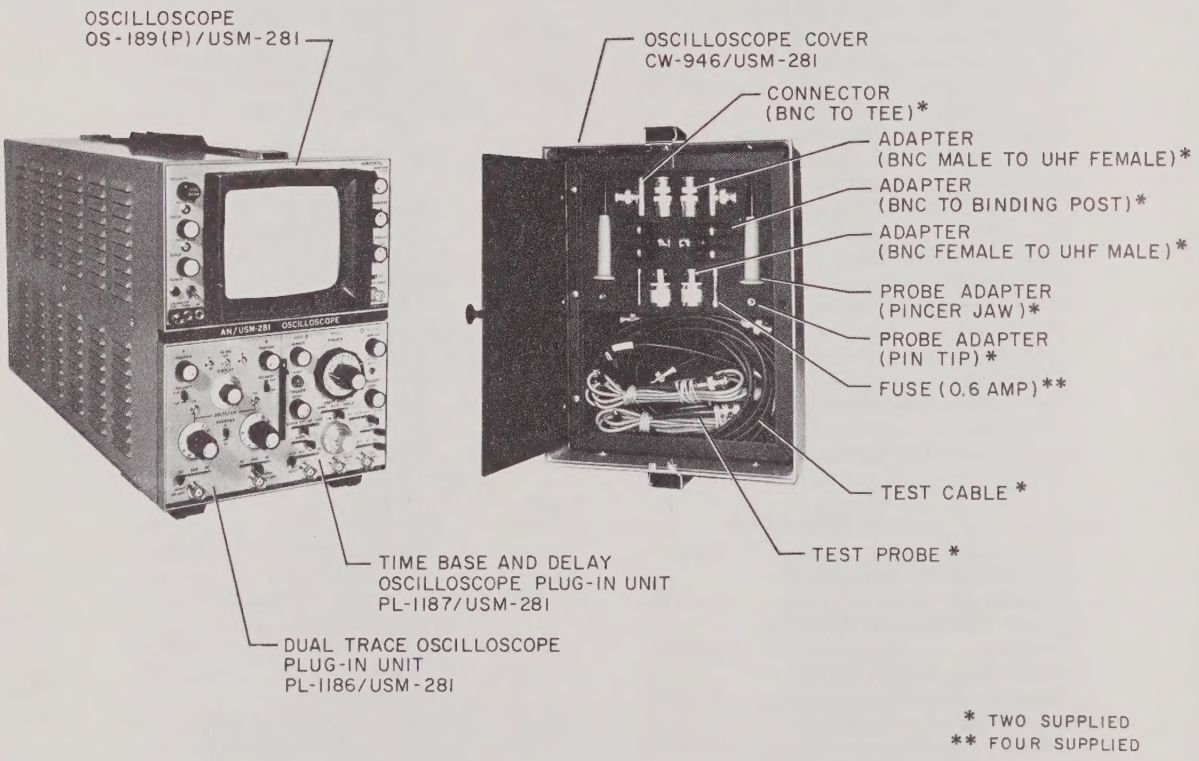


Figure 1-1. Oscilloscope AN/USM-281

SECTION 1

GENERAL INFORMATION

1-1. SCOPE.

This manual contains operation and service instructions with parts breakdown for the AN/USM-281 Oscilloscope. This Technical Manual is in effect upon receipt. Extracts from this publication may be made to facilitate the preparation of other Department of Defense publications.

1-2. GENERAL DESCRIPTION.

The AN/USM-281 Oscilloscope (figure 1-1) is a portable, wideband oscilloscope capable of accurately displaying and measuring simple and complex waveforms from dc to 50 MHz at magnitudes up to 600 volts. The oscilloscope uses solid-state circuitry throughout with no vacuum tubes except the cathode-ray tube (CRT). The oscilloscope is convection cooled and will operate within specifications at ambient temperatures from -28°C to +65°C.

1-3. DESCRIPTION OF UNIT.

The AN/USM-281 Oscilloscope consists of an OS-189(P)/USM-281 Oscilloscope, a PL-1186/USM-281 Dual Trace Oscilloscope Plug-In Unit, a PL-1187/USM-281 Time Base and Delay Oscilloscope Plug-In Unit and a CW-946/USM-281 Oscilloscope Cover. These units are described in the following paragraphs.

a. OS-189(P)/USM-281 OSCILLOSCOPE. - The OS-189(P)/USM-281 Oscilloscope (hereafter referred to as oscilloscope assembly) contains the CRT, the low voltage and high voltage power supplies, a calibrator supply, and the horizontal and gate amplifiers. The CRT is equipped with an internal graticule and variable flood guns to provide parallax-free displays and variable background illumination for high quality photographic recording. The calibrator supply generates a 1 kHz square wave, and provides an output at two levels to front-panel connectors for calibrating the vertical and horizontal amplifiers. The horizontal amplifier input can be coupled directly to the time base plug-in unit or to an external source by means of a front-panel connector and control switch. The output of the horizontal amplifier is coupled directly to the CRT to provide the horizontal trace. The horizontal amplifier also provides a sweep magnifier for expanding the trace to X5 and X10. A rear-panel connector is available for connecting an external signal to produce intensity modulation of the CRT beam. A signal of approximately +2 volts will blank a trace of normal intensity, while a negative signal will intensify the beam.

b. PL-1186/USM-281 DUAL TRACE OSCILLOSCOPE PLUG-IN UNIT. - The PL-1186/USM-281 Dual Trace Oscilloscope Plug-In Unit (hereafter referred to as dual channel vertical amplifier) uses low-drift field-effect transistor (FET) input stages for accurate dc measurement and rapid warm-up time and has a bandwidth from dc to 50 MHz with 3% accuracy. This plug-in unit permits observation of one waveform on either of two channels, or allows simultaneous viewing of two separate waveforms. For displaying two simultaneous waveforms the vertical amplifier provides two alternate sweep modes for viewing high speed traces and a chopped dual sweep for viewing slower displays. By selecting the desired alternate sweep mode each trace can be triggered automatically from the combined channel input or by the B channel input signal only for accurate time comparison of the two input signals. In the chopped mode, the sweep is triggered automatically from the channel B input signal and switching occurs at a 400 kHz rate. Automatic trace blanking during switching time eliminates undesirable switching transients. The dual channel vertical amplifier also provides for combining two waveforms on one trace to produce the algebraic sum or difference of the two waveforms.

c. PL-1187/USM-281 TIME BASE AND DELAY OSCILLOSCOPE PLUG-IN UNIT. - The PL-1187/USM-281 Time Base and Delay Oscilloscope Plug-In Unit (hereafter referred to as time base and delay generator) provides a main sweep variable from 2 sec/cm to 0.1 usec/cm and a delayed sweep variable from 50 msec/cm to 0.1 usec/cm. The time base and delay generator uses tunnel-diode triggering circuits to lock-in waveforms from dc to greater than 90 MHz. This plug-in unit provides the flexibility of a main sweep for viewing simple waveforms or a combination of the main sweep and delayed sweep for observing complex waveforms. The delayed sweep can be superimposed on the main sweep to intensify or expand a portion of the sweep or can be displayed separately at a variable, calibrated delay time for accurate rise time and time differential measurements. The time base generator also provides a single sweep mode for photographing waveforms.

d. CW-946/USM-281 OSCILLOSCOPE COVER. - The CW-946/USM-281 Oscilloscope Cover (hereafter referred to as oscilloscope cover) protects the front panel of the oscilloscope when not in use, and provides storage space for the test probes, test cables, adapters, 230 v fuses and the Operators Manual.

1-4. REFERENCE DATA.

The AN/USM-281 Oscilloscope is designed for continuous operation in ambient temperatures from -28°C to +65°C and to +40°C at a relative humidity of 95%. Within this range the instrument will operate with the characteristics and accuracy specified below.

a. OSCILLOSCOPE ASSEMBLY. -

(1) Calibrator.

(a) Outputs: 250 mv and 10 v peak-to-peak ± 1% at 1 kHz.

(b) Rise time: 3 usec.

(2) CRT: Aluminized P31 phosphor, internal graticule, internal illumination. 12 kv accelerating potential.

(3) Intensity Modulation.

(a) Input resistance: 5.1k ohms.

(b) Blanking voltage: Approximately +2 v from dc to 15 MHz.

(4) Outputs. (All four outputs will drive impedances down to 1k ohm without distortion.)

(a) Main gate: Maximum current output ± 3 ma.

(b) Delayed gate: Maximum current output ± 3 ma.

(c) Main sweep: Maximum current output ± 3 ma.

(d) Delayed sweep: Maximum current output ± 3 ma.

(5) Horizontal Amplifier.

(a) External input bandwidth: Dc coupled, dc to 5 MHz; ac coupled, 5 Hz to 5 MHz.

(b) External input impedance: 1 megohm shunted by 30 pf.

(c) External input sensitivity: 1 v/cm at X1, 0.2 v/cm at X5, and 0.1 v/cm at X10. Variable between ranges with vernier control.

(d) Sweep magnifier: X1, X5, and X10 with 5% accuracy.

b. DUAL CHANNEL VERTICAL AMPLIFIER. - Characteristics listed apply to both channels.

(1) Input sensitivity: Calibrated, 5 mv/cm to 20 v/cm; uncalibrated, up to 50 v/cm.

(2) Vertical magnifier: X1 and X5. X5 position extends vertical sensitivity to 1 mv/cm.

(3) Bandwidth: Dc coupled, dc to 50 MHz; ac coupled, 2 Hz to 50 MHz.

(4) Rise time: Less than 7 nsec with 8 cm input step.

(5) Input impedance: 1 megohm shunted by approximately 25 pf.

(6) Maximum signal input.

(a) Ac coupled: 600 v peak.

(b) Dc coupled: 150 v at 5 mv/cm increasing to 350 v at 20 v/cm.

(7) Polarity of display: + or - up. Front-panel selectable.

(8) Triggering frequency: Provides sufficient triggering signal (to time base) from dc to 50 MHz with a minimum signal input of 0.5 cm peak-to-peak in all modes except CHOP. In CHOP maximum frequency is 100 kHz.

c. TIME BASE AND DELAY GENERATOR. -

(1) Main sweep range: From 2 sec/cm to 0.1 usec/cm in 23 steps with 3% accuracy. Vernier provides continuous adjustment between ranges and extends slowest sweep to at least 5 sec/cm. Horizontal magnifier extends fastest sweep to 10 nsec/cm.

(2) Main sweep triggering mode.

(a) Auto mode: Provides trace in the absence of trigger signal or will accept a trigger signal greater than 50 Hz.

(b) Normal mode: Provides trace on trigger signal only.

(c) Single mode: Provides one sweep when triggered, must be reset to be triggered again.

(3) Main sweep triggering source.

(a) EXT: Provides stable trace with a minimum external signal of 0.5 v peak-to-peak from dc to 50 MHz. Trigger signal amplitude increases to 1 v peak-to-peak at 90 MHz.

(b) EXT ÷ 10: Attenuates external sync signal by 10.

(c) INT: Triggers sweep from signal provided by vertical amplifier.

(d) LINE: Triggers sweep from power line signal.

(4) Trigger coupling (main and delayed).

(a) DC: Accepts signals from dc to 90 MHz.

(b) AC: Attenuates signals below 20 Hz.

(c) ACF: Attenuates signals below 15 kHz.

(d) ACS: Attenuates signals above 30 kHz.

(5) Delayed sweep range: From 50 msec/cm to 0.1 usec/cm in 18 steps with 3% accuracy. Vernier provides continuous adjustment between ranges and extends slowest sweep to at least 125 msec/cm.

(6) Delayed sweep triggering source: AUTO causes delayed sweep to start exactly at end of delay period. INT, EXT, and EXT ÷ 10 have same characteristics as main sweep control in paragraph c(3) above.

(7) Delayed sweep delay time.

(a) Range: Continuously variable from 0.1 usec to 20 sec.

(b) Accuracy: ±1%.

(c) Linearity: ±0.2%

(d) Time jitter: Less than 0.005% of maximum delay of each range.

1-5. EQUIPMENT SUPPLIED.

The equipment supplied with the AN/USM-281 Oscilloscope is listed in table 1-1. As shipped, the test probes, test cables, adapters, and one copy of the Operators' Manual are stored in the oscilloscope cover.

1-6. EQUIPMENT AND PUBLICATIONS REQUIRED BUT NOT SUPPLIED.

A list of equipment and publications required but not supplied is provided in table 1-2. Equipment with equivalent characteristics may be substituted if the listed equipment is not available.

TABLE 1-1. EQUIPMENT SUPPLIED

QTY PER EQUIP	NOMENCLATURE		OVER-ALL DIMENSIONS (IN.)			WEIGHT (LB)
	NAME	DESIGNATION	HEIGHT	WIDTH	DEPTH	
1	Oscilloscope Assembly	OS-189(P)/USM-281	11	8	22-1 2	22
1	Dual Channel Vertical Amplifier	PL-1186/USM-281	4-13/16	4-1/4	13-1 4	4
1	Time Base and Delay Generator	PL-1187/USM-281	4-13/16	4-1/4	14	3-3 4

TABLE 1-1. (Continued)

QTY PER EQUIP	NOMENCLATURE		OVER-ALL DIMENSIONS (IN.)			WEIGHT (LB)
	NAME	DESIGNATION	HEIGHT	WIDTH	DEPTH	
1	Oscilloscope Cover	CW-946/USM-281	11	8	3-5/16	3
1	Mesh Contrast Filter	-	3-5/8	4-9/16	-	-
2*	Test Cable	-	-	-	-	-
2*	Test Probe	-	-	-	-	-
2*	Adapter (BNC male to UHF female)	UG-255/U	-	-	-	-
2*	Adapter (BNC female to UHF male)	UG-273/U	-	-	-	-
2*	Adapter (BNC to binding post)	UG-1035/U	-	-	-	-
2*	Connector (BNC to TEE)	UG-274B/U	-	-	-	-
4*	Fuses (230 v, 0.6 amp, slow-blow)	-	-	-	-	-
2	Technical Manual for Oscilloscope (Volume I)	NAVSHIPS 0969-244-3010	11	8.5	-	-
2**	Operators' Manual for Oscilloscope (Volume II)	NAVSHIPS 0969-244-3020	9.5	7	-	-

*Part of Oscilloscope Cover.
**One copy is part of Oscilloscope Cover.

TABLE 1-2. EQUIPMENT AND PUBLICATIONS REQUIRED BUT NOT SUPPLIED

QTY PER EQUIP	NOMENCLATURE		REQUIRED USE	REQUIRED CHARACTERISTICS
	NAME	DESIGNATION		
1	Voltmeter Calibrator	Hewlett-Packard Model 738AR/BR	Checkout and adjustment of horizontal and vertical amplifiers.	300 mv to 100 v peak-to-peak at 0.2% accuracy.
1	Instruction Book for Voltmeter Calibrator	Hewlett-Packard commercial manual for Model 738AR/BR	-	-
1	Test Oscilloscope	Hewlett-Packard Model 140A with 1420A and 1402A Plug-in Assemblies	Checkout, adjustment and trouble shooting.	Sensitivity 0.1 v/cm. Sweep speed 50 nsec/cm. Rise time 3 usec.
1	Instruction Book for Test Oscilloscope	Hewlett-Packard Commercial Manuals for Models 140A, 1420A and 1402A	-	-

Table 1-2. (Continued)

QTY PER EQUIP	NOMENCLATURE		REQUIRED USE	REQUIRED CHARACTERISTICS
	NAME	DESIGNATION		
1	10:1 Divider	Hewlett-Packard Model 10001A	Used with test oscilloscope.	-
1	Constant Amplitude Signal Generator	Tektronix Type 191A	Checkout bandwidth and triggering circuits.	Frequency range 50 kHz to 90 MHz. Output 10 v peak-to-peak.
1	Instruction Book for Constant Amplitude Signal Generator	Tektronix Commercial Manual for Model 191A	-	-
1	Digital Voltmeter/ Ammeter	Hewlett-Packard Model 3440A with 3441A and 3444A Plug-in Assemblies	Adjustment of low voltage power supply and horizontal gain.	Voltage range to 100 vdc with 0.05% accuracy and current range from 0.20 ma to 2.5 ma with 0.2% accuracy.
1	Instruction Book for Digital Voltmeter and Ammeter	Hewlett-Packard Commercial Manual for Models 3440A, 3441A and 3444A	-	-
1	Electronic Voltmeter	ME-243/FQM	Adjustment of high voltage power supply and trouble shooting.	Voltage to 150 vdc with 2% accuracy.
1	Instruction Book for Electronic Voltmeter	Navships 92648	-	-
1	100:1 Voltage Divider Probe	Hewlett-Packard Model 11045A	Used with Electronic Voltmeter.	-
1	Multimeter	AN/USM-183	Adjustment procedures.	Voltage from 1 mv to 10 vdc with 1% accuracy.
1	Instruction Book for Multimeter	Hewlett-Packard Commercial Manual for Model 412B and Accessories	-	-
1	Variable Resistor	Commercial, No Number	Adjustment of horizontal amplifier gain.	Variable from 40k ohms to 400k ohms.
1	Square Wave Generator	Hewlett-Packard Model 211A	Adjustment procedures.	Frequency to 200 kHz with rise time of 20 nsec or less. Output from 60 mv to 30 v.
1	Instruction Book for Square Wave Generator	Hewlett-Packard Commercial Manual for Model 211A	-	-
1	Oscillator	0-1025/U	Checkout and adjustment procedures.	Frequency from 40 Hz to 100 kHz. Output from 1 v to 10 v peak-to-peak.

Table 1-2. (Continued)

QTY PER EQUIP	NOMENCLATURE NAME	NOMENCLATURE DESIGNATION	REQUIRED USE	REQUIRED CHARACTERISTICS
1	Instruction Book for Oscillator	Hewlett-Packard Commercial Manual for Model 200CD	-	-
1	50-ohm Termination	Hewlett-Packard Model 10100A	Checkout dual channel vertical amplifier.	-
1	Pulse Generator	Hewlett-Packard Model 8000A	Checkout and adjustment of dual channel vertical amplifier.	Rise time 1 nsec or less. Amplitude 0.5 v or more.
1	Instruction Book for Pulse Generator	Hewlett-Packard Commercial Manual for Model 8000A	-	-
1	Square Wave Generator	Hewlett-Packard Model 211B	Adjustment of dual channel vertical amplifier.	Frequency to 100 kHz with rise time less than 5 nsec.
1	Instruction Book for Square Wave Generator	Hewlett-Packard Commercial Manual for Model 211B	-	-
1	LC Meter	Tektronix Type 130	Adjustment of dual channel vertical amplifier.	Range from 30 to 50 pf with 3% accuracy.
1	Instruction Book for LC Meter.	Tektronix Commercial Manual for Model 130	-	-
1	RF Millivoltmeter	AN/URM-155	Check bandwidth of vertical amplifier.	Range from 50 kHz to 50 MHz with 3% accuracy.
1	Instruction Book for RF Millivoltmeter	Hewlett-Packard Commercial Manual for Model 411A and 11027A	-	-
1	Time Mark Generator	Tektronix Type 180	Maintenance of the time base and delay generator.	Range from 10 MHz to 1 sec at 3 v peak-to-peak.
1	Instruction Book for Time Mark Generator.	Tektronix Commercial Manual for Type 180	-	-
1	Plug-In Extender	Hewlett-Packard Model 10407A	Adjustment of dual channel vertical amplifier.	-

1-7. FACTORY OR FIELD CHANGES.

The AN/USM-281 Oscilloscope is a new instrument. No factory or field changes have been made as of date of issue of this manual.

1-8. PREPARATION FOR RESHIPMENT.

The original shipping carton and packaging materials, except for the accordion-pleated pads, should be used for reshipment whenever possible. This carton is designed to give the instrument full protection from shock and vibration incurred in shipment. If the factory-designed carton is not available or has been damaged, pack the AN/USM-281 Oscilloscope in accordance with MIL-P-116 and MIL-E-17555F.

SECTION 2

INSTALLATION

2-1. GENERAL.

This section contains instructions for unpacking, removing and installing plug-in units, installation, and initial inspection and adjustment of the AN/USM-281 Oscilloscope.

2-2. UNPACKING AND HANDLING.

The AN/USM-281 Oscilloscope is shipped with the dual channel vertical amplifier plug-in assembly and the time base and delay generator plug-in assembly installed. The Operators' Manual is placed within the front cover prior to shipment. Exercise care when removing the unit from the shipping container to prevent damage to the equipment. After removing the instrument, the packaging material should be retained for possible future use.

2-3. POWER REQUIREMENTS.

The AN/USM-281 Oscilloscope is designed to operate with either a 115 vac or a 230 vac ±10%, single phase, 50 Hz to 1 kHz power source capable of delivering 100 watts. When shiped from the factory, this instrument is set for 115 vac operation. If the instrument is to be operated on 230 vac, set the rear-panel switch to 230 vac and replace the four 1.25 amp fuses (rear panel) with the 0.6 amp fuses stored in the cover. The 115/230 switch selects the proper transformer setting for the desired voltage. This switch and the fuses should always be checked before connecting the instrument to a power source to avoid damage to the unit.

2-4. SITE SELECTION.

The AN/USM-281 Oscilloscope is a versatile, lightweight instrument designed to operate satisfactorily over a wide range of environments. The portability and accuracy of the instrument makes it ideal for use in shipboard, airborne, and land based electronic maintenance facilities.

2-5. PLUG-IN UNIT REMOVAL AND INSTALLATION.

For ease of handling, the dual channel vertical amplifier plug-in assembly and the time base and delay generator plug-in assembly are locked together, and removed or installed in the oscilloscope assembly as a single unit. Instructions for removing

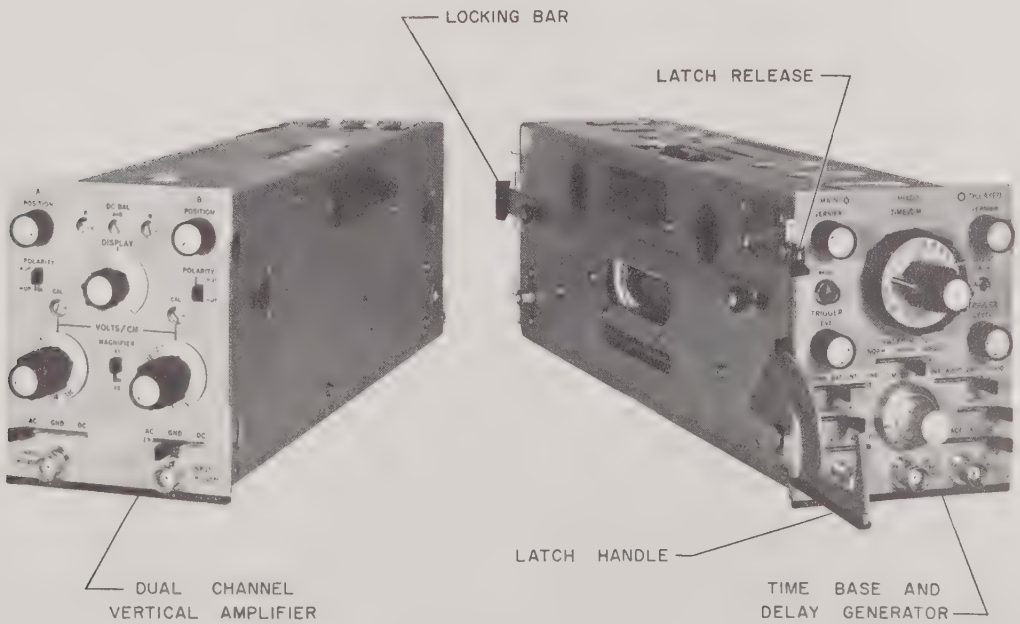


Figure 2-1. Plug-In Unit Removal and Installation

and installing the plug-in units are provided in the following paragraphs.

a. REMOVAL. - Remove the plug-in units from the oscilloscope assembly as follows:

(1) Lift latch release and rotate latch handle downward away from panel (see figure 2-1).

(2) Using latch handle, pull plug-in assemblies from oscilloscope assembly.

(3) Pull locking bar to the rear.

(4) Separate plug-in assemblies.

b. INSTALLATION. - To install the plug-in units in the oscilloscope, reverse the above procedure making sure locking bar is to the rear before mating the two plug-in units, and insuring that the connectors on the plug-ins are aligned before pushing locking bar forward.

2-6. INSTALLATION REQUIREMENTS.

The AN/USM-281 Oscilloscope is a portable unit and normally will not be permanently installed in any one location. When choosing a location for the instrument, select an area that provides several inches of space around the cabinet to allow adequate ventilation, and insure that provisions for grounding the oscilloscope (through the power cord) are available.

2-7. CABLE ASSEMBLIES.

No special cables are required for installation of the oscilloscope. The test probes, test cables, connectors, fuses and adapters supplied with the oscilloscope have the following use:

a. TEST PROBES. - Two test probes, each consisting of a 3-foot coaxial cable with a BNC connector on one end and a 10:1 divider probe on the opposite end, are supplied with the oscilloscope. The 10:1 probe increases the voltage range of the oscilloscope, and is supplied with several tips for flexibility in connecting the probe to various types of terminals and connectors.

b. TEST CABLES. - Two 8-foot coaxial cables with BNC connectors on both ends are provided for connecting the oscilloscope to various types of equipment having BNC connectors.

c. ADAPTERS AND TEE-CONNECTORS. - The following adapters and connectors are supplied with the oscilloscope:

(1) Two BNC male to UHF female Type UG-255/U adapters and two BNC female to UHF male Type UG-273/U adapters for making connections to equipment having UHF connectors.

(2) Two BNC to binding posts Type UG-1035/U adapters for making connections to test leads terminated in banana connectors.

(3) Two BNC to tee-connectors Type UG-274 B/U for making multiple input connections to equipment having BNC connectors.

d. FUSES. - Four 0.6 amp fuses are stored in the cover for use when operating on 230 vac input power. When installed in the four fuse holders on the rear of the instrument, the two left fuses are spares and the two right fuses are inserted in the input power lines.

2-8. INSPECTION.

Upon receipt of the AN/USM-281 Oscilloscope and before applying power check the unit for damage that may have occurred in transit. To check for damage, the plug-in assemblies should be removed and the entire unit inspected for broken or loose control knobs, bent or broken connectors, loose wires, and dents or scratches on the cabinet. If the unit appears free from damage, replace the plug-in assemblies in the oscilloscope.

2-9. INITIAL TURN-ON AND ADJUSTMENT.

To apply power to the oscilloscope, perform the turn-on and adjustment procedure in paragraph 3-5. The only adjustments required should be front-panel adjustments. All internal adjustments are made at the factory, and the instrument should be ready for use on receipt. After completing turn-on and adjustment, perform the reference standards procedures in paragraph 5-4 to insure that the unit is functioning properly.

SECTION 3

OPERATION

Operation, Section 3, is included as Volume II of this Technical Manual. Volume II is identified as "Operators' Manual for Oscilloscope AN/USM-281", NAVSHIPS 0969-244-3020.

SECTION 4

TROUBLE SHOOTING

4-1. LOGICAL TROUBLE SHOOTING.

This section contains trouble-shooting information for the AN/USM-281 Oscilloscope. Trouble shooting is based on the following six logical steps:

a. SYMPTOM RECOGNITION. - This is the first step in the trouble-shooting procedure and is based on a thorough knowledge and understanding of the instrument and its' operating characteristics and limitations. Suspected malfunctions are not always the result of component failure, but are often caused by improper control settings and adjustments. Therefore, a thorough knowledge of Section 3 (operation) is necessary to avoid erroneous malfunction indications. A type of malfunction that is not always apparent is a condition of less than peak performance. To evaluate the apparent and not so apparent troubles requires considerable experience on the part of the technician. If oscilloscope performance is doubtful the reference standards procedures in Section 5 should point out most oscilloscope malfunctions.

b. SYMPTOM ELABORATION. - When an equipment trouble has been recognized use all available instrument aids to further isolate the trouble to a functional section. Much information can be gained by manipulating the operating controls, and by using the CALIBRATOR output to inject a signal into the vertical and horizontal sections while observing oscilloscope response. When an unusual indication is observed it should serve as a symptom for further isolating the trouble.

c. LISTING PROBABLE FAULTY FUNCTION. - The next step in the logical trouble shooting is to formulate a number of mental choices as to the cause and functional section of the malfunction. This decision must be based on a complete understanding of instrument operation, and a full identification of the trouble symptom. With this in mind, consult the overall functional description and the associated block diagram (figure 4-1) and select the possible faulty functional sections.

d. LOCALIZING THE FAULTY FUNCTION. - After selecting the possible faulty functional sections the trouble must be systematically isolated to one functional section. This is accomplished by testing each section in the most efficient order. Use the overall trouble shooting and the servicing block diagram (figure 4-2) as an aid in isolating the problem to a single functional section.

e. LOCALIZING TROUBLE TO THE CIRCUIT. - When the problem has been isolated to a single functional section, refer to the circuit description and functional and servicing block diagram for that section and make additional "logical choices" as to which circuit is at fault. The trouble-shooting information on the applicable section and the schematic diagrams in Section 5 should also be used to further isolate the faulty circuit. When the faulty circuit is identified, make voltage measurements and waveform observations in accordance with the servicing block diagram and schematic diagrams to locate the defective component. Before making voltage measurements and waveform comparisons, always set oscilloscope controls as indicated in the applicable trouble-shooting chart or block diagram to prevent erroneous readings due to improper settings. Also observe all instructions for injecting a signal into the circuit, as many of the waveforms are present only when an external signal is applied.

f. FAILURE ANALYSIS. - When the trouble has been located, review the procedure followed up to this point to determine exactly why the fault affected the instrument in the manner it did. This review is necessary to make certain that the fault discovered is the cause of the malfunction and not the result of the malfunction.

4-2. OVERALL FUNCTIONAL DESCRIPTION.

The oscilloscope requires three signals to produce a usable display on the CRT. These are intensity, horizontal deflection, and vertical deflection. Refer to figure 4-1 for the functional block diagram of the oscilloscope. The circuitry for producing intensity is included in the oscilloscope assembly and consists of the low and high voltage supplies and the gate amplifier. The circuitry for producing internal horizontal deflection consists of the horizontal amplifier contained in the oscilloscope assembly; and the internal trigger amplifier, main and delayed trigger generators, and main and delayed sweep generators located in the time base and delay generator. The oscilloscope assembly also contains a horizontal preamplifier for accepting external horizontal deflection signals. The circuitry for producing vertical deflection is located in the dual channel vertical amplifier and consists of a channel A and B attenuator and preamplifier, a channel A and B input amplifier and gate control, a main amplifier, a multivibrator, and a sync amplifier. To aid in trouble shooting, these main circuits have been divided into functional sections. These functional sections are listed and briefly described in the following paragraphs.

4-3. FUNCTIONAL SECTION DESCRIPTION.

The following are the oscilloscope functional sections:

a. LOW VOLTAGE POWER SUPPLY. - The low voltage power supply contains regulated +100 vdc, +15 vdc, -12.6 vdc, and -100 vdc supplies; and an unregulated +23 vdc supply. The +23 vdc supply is used only by the high voltage supply oscillator. The regulated supplies provide all operating voltages used throughout the oscilloscope.

b. HIGH VOLTAGE POWER SUPPLY. - The high voltage power supply generates three regulated voltages and applies these to the cathode, control grid, and post accelerator of the CRT to provide the accelerating potential required to produce a trace on the CRT.

c. HORIZONTAL AMPLIFIER. - The horizontal amplifier section (includes horizontal preamplifier) accepts an external or internal time base signal and

amplifies the signal to the voltage level required to produce the horizontal displacement of the CRT beam.

d. GATE AMPLIFIER. - The gate amplifier accepts an unblanking gate signal from the time base and delay generator (during internal operation), a chopped blanking signal from the dual channel vertical amplifier (during chopped mode), and a Z-AXIS signal (when applied from an external source). These signals are averaged and amplified by the gate amplifier, and the output is applied through the high voltage supply to the control grid of the CRT. This control signal causes the CRT beam to be cut off during retrace, during switching when operating in the dual channel chopped mode and produces intensity modulation of the CRT beam when a Z-AXIS input is applied.

e. CALIBRATOR. - The calibrator is a free -running multivibrator that oscillates at a 1 kHz frequency and provides a square wave output to the front-panel connectors. The calibrator outputs are useful in adjusting and trouble shooting the oscilloscope. The calibrator supply has no internal function.

f. MAIN AND DELAYED SWEEP AND MAIN AND DELAYED GATE OUTPUT AMPLIFIERS. - These four amplifiers are single-stage, emitter-follower amplifiers that accept the main sweep, main gate, delayed sweep, and delayed gate signals and provide a low impedance output to four rear-panel connectors. These amplifiers have no internal function.

g. DUAL CHANNEL VERTICAL AMPLIFIERS AND ATTENUATORS. - This section includes the A and B input attenuators and preamplifier, A and B amplifiers and gate control, delay line, and the output amplifier. Each input attenuator provides 12 levels of compensated attenuation and applies a reduced signal to its respective input amplifier (includes preamps). The input amplifiers convert each input to a differential signal and apply an amplified output signal through a gate control circuit and delay line to the output amplifier. The gate control circuit is controlled by the multivibrator and (depending on the setting of the vertical DISPLAY switch) determines which signal (channel A and/or channel B) is applied to the output amplifier. The delay line delays the signal 160 nsec to allow the internal trigger signal from the sync amplifier enough time to start the sweep. The output amplifier boosts the signal to the level necessary to drive the vertical deflection plates of the CRT.

h. MULTIVIBRATOR. - The multivibrator provides the control signal to the gate control circuit and determines which vertical channel is displayed. In the chopped mode of operation the multivibrator is free-running and switches at a 400 kHz rate to alternately switch the A and B channels on and off. In this mode the output of the multivibrator is also applied to a blanking amplifier to provide a blanking signal through the gate amplifier to the CRT during switching time. In the two alternate modes of operation, the multivibrator is bistable and switches only when triggered by the time base triggering signal (from the gate amplifier in the oscilloscope assembly). This causes the multivibrator to switch channels at the completion of each sweep. In the A + B mode of operation the multivibrator allows the output of both channels to pass through the gate control circuit and apply their combined output to the output amplifier.

i. SYNC AMPLIFIER. - The composite vertical signal from the gate control, and the signal from the channel B amplifier are applied to the sync amplifier. The sync amplifier (depending on the setting of the vertical DISPLAY switch) amplifies one of these input signals and converts it to a single-ended output. The output signal is coupled to the time base and delay generator where it may be used to trigger the sweep. In the ALT, A + B, A and B modes of operation the composite vertical signal is amplified by the sync amplifier and coupled to the time base and delay generator. In the ALT B TRIGGER and CHOP B TRIGGER modes of operation the channel B signal is amplified by the sync amplifier and supplied to the time base and delay generator.

j. MAIN TRIGGER GENERATOR AND AMPLIFIER. - The main trigger generator (depending on the setting of the main trigger source switch) receives a trigger signal from an internal, external, or line source. If the internal source is selected, the trigger signal from the sync amplifier is amplified by the internal trigger amplifier (in the time base and delay generator) before it is applied to the trigger generator. The main trigger generator and amplifier amplifies the selected trigger signal, compares it to a preset trigger level (determined by the main TRIGGER LEVEL control) and provides a sharp negative trigger pulse to the main gate generator (figure 4-2). If the main trigger generator receives no input trigger signal while operating in the NORM or SINGLE mode, it produces no trigger output. In the AUTO mode the trigger generator produces a trigger output in the absence of an incoming trigger signal.

k. MAIN SWEEP GENERATOR. - The main sweep generator functional section (figure 4-1) consists of the main gate generator, the main integrator, a hold-off circuit and the main Schmitt Trigger. See figure 4-2. When the main gate generator is triggered by the main trigger generator it produces a negative rectangular gate pulse. The gate pulse is applied through the sweep display switch to the gate amplifier in the oscilloscope assembly to unblank the CRT. At the same time the gate signal enables the main integrator and the integrator begins generating a positive-going sawtooth (sweep) voltage at a rate determined by the setting of the main TIME/CM switch. This sweep signal is applied through the sweep display switch (in the MAIN and MIXED modes) to the horizontal amplifier in the oscilloscope assembly to drive the horizontal delfection plates. The main sweep signal is also applied to the main Schmitt Trigger and the hold-off circuit. When the sweep output reaches a preset level (determined by sweep length adjustment) the Schmitt Trigger switches and cuts off the gate generator to terminate the sweep signal. The sweep is removed from the hold-off circuit and, after a delay, the hold-off circuit applies a negative signal to the Schmitt Trigger causing it to switch and reset the main gate generator to the ready condition. When the main gate generator is in the ready condition the next trigger pulse causes the gate to repeat the sweep cycle. In the SINGLE mode of operation the hold-off output is disabled and the Schmitt Trigger and gate can only be reset by pressing the RESET pushbutton.

l. DELAYED TRIGGER GENERATOR AND AMPLIFIER. - The delayed trigger generator (depending on the setting of the delayed trigger source switch) receives a signal from an internal, external, or auto

source. If the internal or external source is selected, the delayed trigger generator and amplifier amplifies the incoming trigger signal, compares it to a preset trigger level (determined by setting of delayed TRIGGER LEVEL control) and provides a sharp negative trigger pulse to the delayed gate generator (figure 4-2). If the auto trigger source is selected, the delayed trigger generator is disabled and the sweep comparator (in the delayed sweep generator) provides a positive trigger pulse to the delayed trigger output amplifier. The delayed trigger output amplifier amplifies and inverts the pulse to provide a negative trigger signal to the delayed gate generator.

m. DELAYED SWEEP GENERATOR. - The delayed sweep generator functional section (figure 4-1) consists of the delayed gate generator, the delayed integrator, a sweep comparator, and the delayed Schmitt Trigger. See figure 4-2. The delayed gate generator and delayed integrator function the same as the main gate generator and main integrator (paragraph k above). The delayed sweep output is applied through the sweep display switch to the horizontal amplifier only in the MIXED and DELAYED sweep modes. In the MIXED mode both the main and delayed sweeps are applied to the horizontal amplifier. In the DELAYED mode, only the delayed sweep is displayed. The sweep comparator receives the main sweep signal from the main time generator and compares it to a voltage level set by the CM DELAY control. When the main sweep voltage exceeds the set level, the comparator provides a positive output pulse to reset the delayed Schmitt Trigger and enable the delayed gate generator. If the auto source is selected, the comparator output is also applied to the trigger generator as previously described. When the delayed gate is enabled the first trigger pulse (immediately in auto) starts the sweep cycle. The delayed sweep cycle is terminated when the sweep reaches a predetermined voltage level and switches the delayed Schmitt Trigger to disable the gate.

4-4. OVERALL OSCILLOSCOPE TROUBLE SHOOTING.

The most important prerequisite for successful trouble shooting is a thorough understanding of instrument operation and function. Suspected malfunctions are often caused by improper control settings such as: intensity set too low, display or mode switch in wrong position, trigger level maladjusted, CM DELAY set to 0, etc. Prior to trouble shooting the instrument, refer to the operating instructions in Section 3 to insure that controls are set properly. When it has been determined that the controls are in the proper position and the instrument is still not functioning properly, turn the oscilloscope off and remove the oscilloscope covers per paragraph 5-5a. Thoroughly inspect the instrument for burned or loose components, loose wire connections, faulty switch contacts, or any similar condition suggesting a source of trouble. If a thorough visual inspection fails to locate the source of the malfunction, apply power to the oscilloscope and trouble shoot the instrument as directed in the following paragraphs.

a. TEST EQUIPMENT. - Test equipment required for trouble shooting the oscilloscope is listed in table 4-1.

Table 4-1. TEST EQUIPMENT REQUIRED FOR TROUBLE SHOOTING

DESIGNATION	NAME
Hewlett-Packard Model 140A with 1420A and 1402A plug-in assemblies	Oscilloscope
ME-243/FQM	Electronic Voltmeter
Hewlett-Packard Model 211A	Square Wave Generator
Hewlett-Packard Model 738AR/BR	Voltmeter Calibrator

b. TROUBLE-SHOOTING PROCEDURE. - The procedure for trouble shooting the overall oscilloscope is given in table 4-2. This procedure utilizes indications on the CRT, in response to control settings, as a means of localizing the trouble to a single or group of functional sections. Where improper indications are obtained, table 4-2 directs the technician to the probable functional section or sections of the oscilloscope which deserve a more detailed check. The probable functional sections should then be checked in the most logical order. Refer to the trouble-shooting text for each functional section concerned and check that section in accordance with the trouble-shooting information and trouble-shooting chart provided. Each section also provides a servicing block diagram that includes voltages, waveforms and the control settings required to obtain them.

c. OVERALL SERVICING BLOCK DIAGRAM. - The overall servicing block diagram for the oscilloscope is shown in figure 4-2. This diagram shows the overall relationship between the functional units and the typical waveforms to be expected. Since most waveforms in the dual channel vertical amplifier are dependent on the applied input signal, these waveforms have been omitted from the servicing diagram.

d. TEST POINTS. - Significant test points are identified on functional and servicing block diagrams by use of test-point symbols. Star test-point symbols are assigned to those test points used to isolate functional sections or circuit groups while trouble shooting. Circle test-point symbols are assigned to test points helpful in isolating faulty circuits. Many of these test points are not marked on the equipment, however, the test points shown by the schematic symbol for a test point are actual standoff-terminals on the equipment. These test points appear on the diagrams with numerical designators (such as TP401, TP301, etc.) in addition to the letter type designations (A, B, C, etc). To aid in identifying and locating test points, a small dot is etched on the circuit board assemblies next to the emitter lead of transistors, the source lead of FETs, the cathode lead of diodes and the positive lead of electrolytic capacitors.

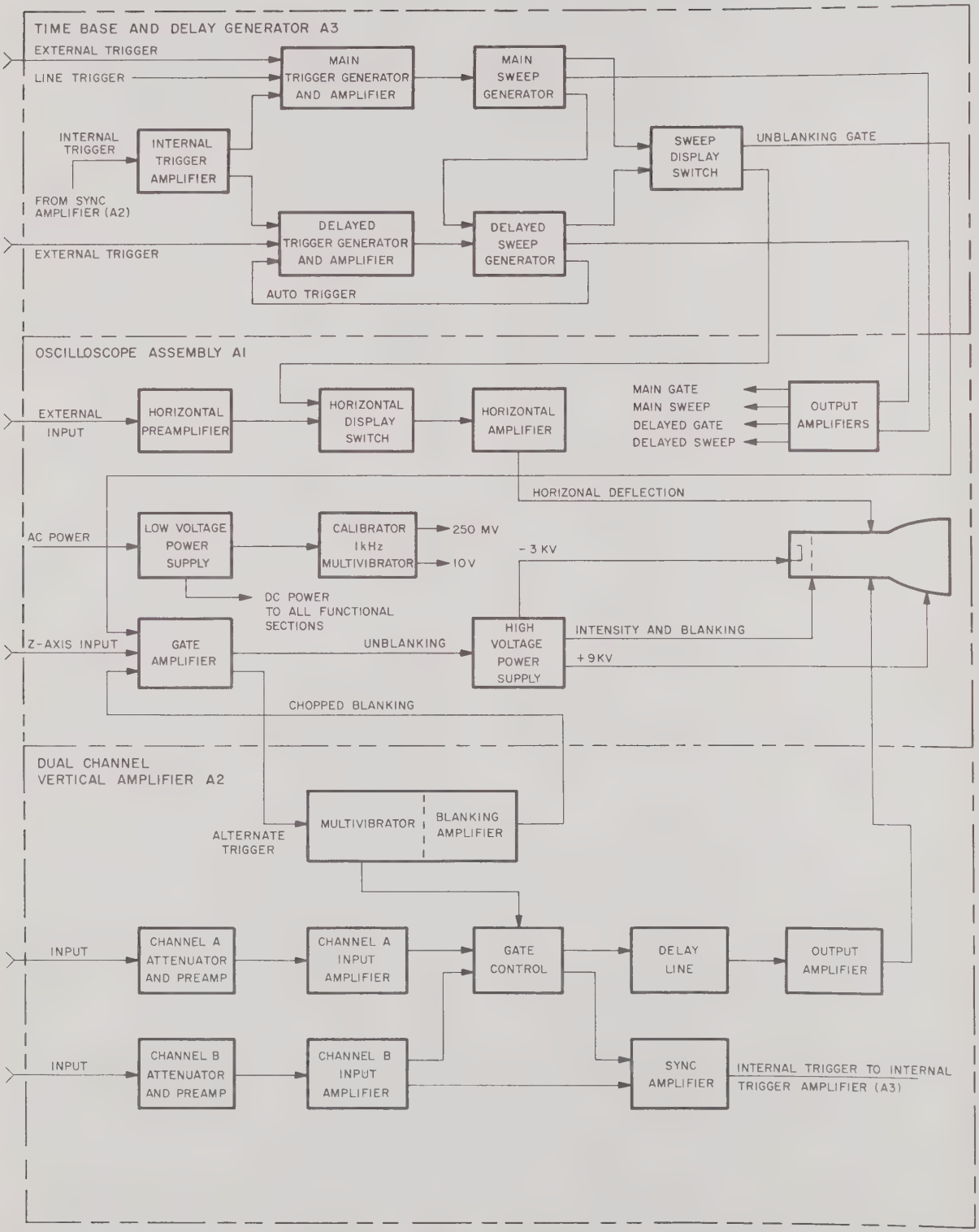


Figure 4-1. Oscilloscope Overall Functional Block Diagram

TABLE 4-2. OVERALL OSCILLOSCOPE TROUBLE SHOOTING

STEP	ACTION	RESULTS	NEXT STEP
1	Apply power to oscilloscope and allow a 15 minute warm-up. Set oscilloscope controls as follows: Set horizontal display to EXT CAL. Set horizontal MAGNIFIER to X1. Set vertical DISPLAY to A. Set channel A input coupling to GND. Set vertical MAGNIFIER to X1. Set channel A and B vernier VOLTS/CM to CAL. Set sweep display to MAIN.	POWER indicator lights and small round spot appears on CRT.	5
		NOTE It may be necessary to adjust INTENSITY, FOCUS, and/or ASTIGMATISM.	
		POWER indicator lights and spot does not appear on CRT.	2
		If POWER indicator does not light and spot does not appear on CRT, check ac input fuses (A1F401 and A1F402) and low voltage power supply functional section.	
2	Press and hold FIND BEAM.	If spot appears, adjust vertical and horizontal position controls to center spot.	3
		Spot does not appear.	4
3	Release FIND BEAM and, if required, increase intensity.	Spot appears.	5
		Spot does not appear.	4
4	Remove plug-in units and press FIND BEAM.	If spot appears, check dual channel vertical amplifier functional section and main sweep generator functional section.	
		If spot does not appear, check low voltage power supply, high voltage power supply, horizontal amplifier, and gate amplifier functional sections. If these sections are operating properly, check CRT.	
5	Rotate A POSITION control through its range, then center spot vertically.	Spot moves vertically across screen, then centers.	6
		If spot does not move, check vertical CRT connections and dual channel vertical amplifier and attenuators functional section.	
		If spot moves but can not be centered, check dual channel vertical amplifiers and attenuators functional section.	
6	Rotate HORIZONTAL POSITION control through its range, then center spot horizontally.	Spot moves horizontally across screen, then centers.	7

TABLE 4-2. (Continued)

STEP	ACTION	RESULTS	NEXT STEP
6 (Cont)		If spot does not move horizontally or will not center, check horizontal amplifier functional section.	
7	Set oscilloscope controls as follows: Set horizontal DISPLAY to INT. Set main TIME/CM to .5 MSEC. Set delayed TIME/CM to OFF. Set SWEEP MODE to AUTO. Set main trigger coupling to INT. Set delayed trigger source to AUTO.	Baseline appears on CRT.	8
		If baseline does not appear, check main sweep generator functional section, sweep display switch and A3J1 pin 1.	
8	Rotate delayed TIME/CM ccw to .2 MSEC and rotate CM DELAY cw from 0 to 9.99	Intensified trace appears at left of baseline and moves across CRT from left edge of graticule to right edge.	9
		If intensified trace does not appear, check delayed sweep generator functional section, INTENS RATIO adjustment and sweep display switch.	
		If intensified trace appears but does not move as CM DELAY is rotated, check CM DELAY and sweep comparator portion of delayed sweep generator functional section.	
9	Set oscilloscope controls as follows: Set delayed TIME/CM to OFF. Set horizontal MAGNIFIER to X5. Set horizontal DISPLAY to EXT CAL. Set horizontal coupling to AC. Connect 10:1 divider probe from CALIBRATOR 10V output to horizontal EXT INPUT.	A baseline 5 cm (± 5 mm) wide appears.	11
		Baseline appears but is out of tolerance.	10
		If baseline does not appear, check calibrator functional section.	
10	Disconnect 10:1 divider probe and observe CALIBRATOR 10V output with test oscilloscope.	If CALIBRATOR 10V output is 9.9 to 10.1 v peak-to-peak, check horizontal amplifier functional section.	
		If CALIBRATOR 10V output is out of tolerance, check calibrator functional section.	

TABLE 4-2. (Continued)

STEP	ACTION	RESULTS	NEXT STEP
11	Disconnect 10:1 divider probe from horizontal EXT INPUT and connect to A INPUT.	A 1 kHz square wave with 1 cm (± 2 mm) vertical deflection appears.	12
	Set oscilloscope controls as follows: Set horizontal MAGNIFIER to X1. Set horizontal DISPLAY to INT. Set channel A input coupling to AC. Set channel A VOLTS/CM to 1.	If square wave appears but is unstable, adjust main TRIGGER LEVEL. If display does not stabilize, check main trigger generator and amplifier functional section.	
		If no vertical display appears, check dual channel vertical amplifiers and attenuators functional section.	
12	Set vertical MAGNIFIER to X5.	Vertical display increases to 5 cm (± 5 mm).	13
		If vertical display does not increase to 5 cm (± 5 mm), check dual channel vertical amplifiers and attenuators functional section.	
13	Disconnect 10:1 divider probe from A INPUT and connect to B INPUT. Set oscilloscope controls as follows: Set vertical MAGNIFIER to X1. Set channel B input coupling to AC. Set channel B VOLTS/CM to 1.	A 1 kHz square wave with 1 cm (± 2 mm) vertical deflection appears.	14
		If no vertical display appears, check dual channel vertical amplifier functional section (channel B amplifier).	
14	Disconnect divider probe. Set channel A and B input coupling to GND and vertical DISPLAY to ALT B. Adjust A POSITION and B POSITION to provide two separate baselines.	Two baselines appear.	15
		If only one baseline appears, check multivibrator and gate amplifier functional sections.	
15	Set vertical DISPLAY to CHOP B TRIGGER and increase INTENSITY slightly above normal.	If no vertical switching transients appear on CRT, major oscilloscope functional sections are operating properly.	
		If vertical switching transients appear on CRT, check multivibrator functional section (blanking amplifier).	

4-5. LOW VOLTAGE POWER SUPPLY.

a. LOW VOLTAGE POWER SUPPLY FUNCTIONAL DESCRIPTION. - The low voltage power supply contains four regulated supplies and one unregulated supply. See figure 4-3. When power is applied to the oscilloscope, transformer A1T401 reduces the 115 or 230 vac input and provides five secondary outputs to the low voltage power supply. The power supply rectifies these secondary outputs and produces regulated +100 vdc, +15 vdc, -12.6 vdc, and -100 vdc supplies; and an unregulated +23 vdc supply. The -100 vdc output is used as a reference voltage for the other regulated supplies and is discussed first.

(1) -100 VDC SUPPLY. One of the secondary outputs of A1T401 is coupled to a bridge rectifier consisting of A1A6CR426 through A1A6CR429. This ac input is rectified, filtered, and applied through fuse A1F406 to the -100 vdc supply. The output of the -100 vdc supply is controlled by series regulator A1Q414 in the power supply ground path. Resistors A1A7R448, A1A7R449, and A1A7R450 sample the regulator output and a variable tap on A1A7R449 provides a control voltage to the base of A1A7Q416. Any change in output voltage is sensed at the base of A1A7Q416 and a larger change is coupled through A1A7V402 and

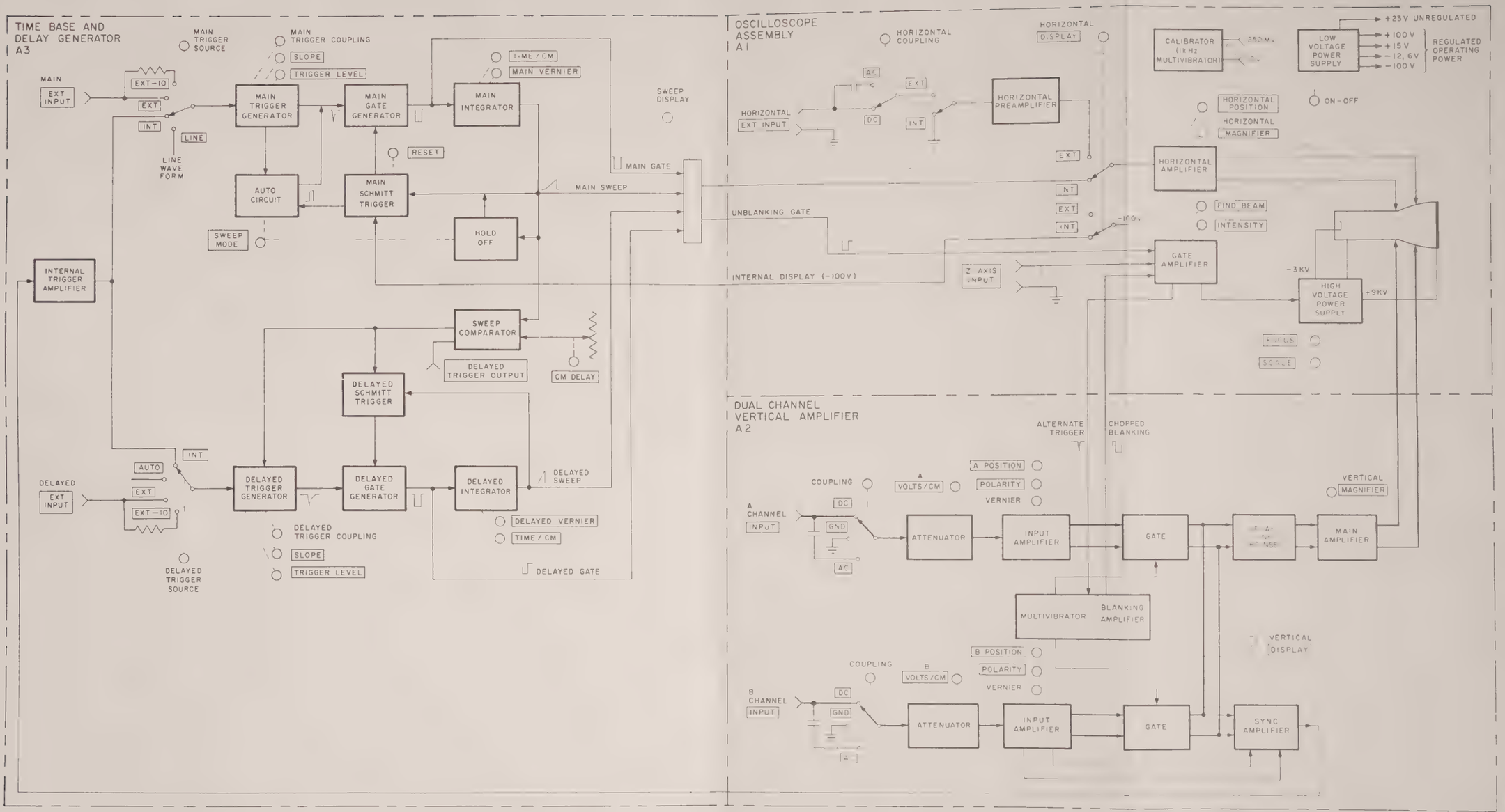


Figure 4-2. Oscilloscope Overall Functional and Servicing Block Diagram

A1A7Q415 to the emitter of A1A7Q416. The difference voltage produced is coupled from the collector of A1A7Q416 to the base of driver transistor A1A7Q413. The output of driver A1A7Q413 is coupled to regulator A1Q414 which returns the output of the supply to normal. The output voltage of the regulator is determined by the setting of resistor A1A7R449 which controls the bias of A1A7Q416. Capacitor A1A7C427 filters the -100 vdc output to prevent transients from affecting the regulator. A1A7C425 and A1A7R442 provide an average level (filter high frequencies) to the driver to prevent oscillations.

(2) +100 VDC SUPPLY. The +100 vdc supply operates the same as the -100 vdc supply with the following exceptions. Transistors A1A7Q403 and A1A7Q404 operate as an emitter-coupled differential amplifier. The base of A1A7Q403 is held at a constant voltage by A1A7V401. Any change in output voltage is coupled to the base of A1A7Q404 through A1A7R412 and is compared to the reference level established by A1A7Q403. The difference voltage produced is coupled through driver A1A7Q402 to output regulator A1Q401 which returns the supply to normal. The +100 vdc supply also requires a 105 vdc bias voltage for transistors A1A7Q402 and A1A7Q404. This 105 vdc supply is provided by a bridge rectifier consisting of A1A6CR401 through A1A6CR404, regulated by zener diode A1A7VR401 and filtered by A1A6C401. The output voltage of the +100 vdc supply is determined by the setting of A1A7R412.

(3) +15 VDC SUPPLY. The +15 vdc supply receives a rectified output from the bridge rectifier (A1A6CR413 through A1A6CR416) through fuse A1F404. The output of the +15 vdc supply is controlled by series regulator A1Q406. Resistors A1A7R422, A1A7R423 and A1A7R424 compare the +15 vdc output with the -100 vdc supply. A variable tap on A1A7R423 applies a control voltage to the base of A1A7Q408. Any change in output voltage is sensed by A1A7Q408. The change is amplified and inverted and coupled from the collector of A1A7Q408 through driver A1A7Q405 to regulator A1Q406. The change is in the proper direction to return the supply to normal. The output of the +15 vdc supply is determined by the setting of A1A7R423. A1A7Q407 and A1A7R419 provide overcurrent protection for the regulator. Resistor A1A7R419 is in series with the regulator output and develops a voltage drop proportional to current output. If the current output rises above a safe level, the voltage difference across A1A7R419 turns A1A7Q407 on. The negative -going signal from the collector of A1A7Q407 is coupled through driver A1A7Q405 to series regulator A1Q406 turning it off.

(4) -12.6 VDC SUPPLY. The -12.6 vdc supply operates the same as the +15 vdc supply with the following exceptions. Resistors A1A7R433, A1A7R434, and A1A7R435 are connected between the -100 vdc reference supply and ground. A variable tap on A1A7R434 is connected to the base of A1A7Q412 and holds the base at a constant preset level. Any change in output voltage is coupled directly to the emitter of A1A7Q412 and produces a corresponding change on the collector. This change is coupled through driver A1A7Q409 to regulator A1A7Q410 to return the supply to normal. Current limiter A1A7Q411 operates as previously explained. Diode A1A7CR425 in the A1A7Q412 base circuit provides temperature compensation and variable resistor A1A7R434 determines output voltage.

(5) +23 VDC UNREGULATED SUPPLY. The +23 vdc supply is obtained from a bridge rectifier consisting of diodes A1A6CR413 through A1A6CR416, filtered by A1A6C412. No regulation is provided.

b. LOW VOLTAGE POWER SUPPLY TROUBLE SHOOTING. - The trouble-shooting chart for the low voltage power supply iunctional section is provided in table 4-3 and the servicing block diagram is shown in figure 4-3. When trouble is suspected in the low voltage power supply, the -100 vdc and the +100 vdc supplies must be checked first because the output of these supplies is used in the other regulated supplies. If the +100 vdc supply is variable but will not reach 100 vdc, check the +105 vdc supply (A1A6CR401 through A1A6CR404, A1A6C401, A1A6R401 and A1A6VR401). After locating the trouble and completing the repair, perform the low voltage adjustment procedures given in Section 5. When adjusting the supplies, adjust the -100 vdc supply first and then the +100 vdc supply before adjusting the +15 vdc and -12.6 vdc supplies.

c. USEFUL ILLUSTRATIONS. Illustrations useful in maintaining this functional section are: Figures 4-3, 5-18, 5-19 and 5-30.

TABLE 4-3. LOW VOLTAGE POWER SUPPLY TROUBLE SHOOTING

STEP	ACTION	RESULTS	NEXT STEP
	-100 VDC SUPPLY		
1	Use a test oscilloscope to check voltage and ripple at test point D (TP404). See figure 4-3.	Voltage is correct (-100 vdc ± 2%), no ripple.	4
		Ripple present.	2
		Voltage present but not -100 vdc (± 2%).	3
		If no voltage, check fuse A1F406 and check for open regulator A1Q414.	

TABLE 4-3. (Continued)

STEP	ACTION	RESULT	NEXT STEP
2	Measure ripple frequency at test point D (TP404).	If ripple frequency is 60 Hz, check rectifier diodes A1A6CR426 through A1A6CR429.	
		If ripple frequency is 120 Hz, check filter capacitors A1A6C424 and A1A7C427.	
3	Measure voltage at test point D (TP404) while varying A1A7R449.	If voltage is variable but can not be adjusted to -100 vdc, check A1A7V402, A1A7VR403, A1A7R439, A1A7R447, A1A7C425 and A1A7C426.	
		If voltage is not variable, check for shorted or open A1A7Q413, A1Q414, A1A7Q415 and A1A7Q416.	
	+100 VDC SUPPLY		
4	Measure voltage and check for ripple at test point A (TP401).	Voltage is correct (+100 vdc ± 2%), no ripple.	7
		Ripple present.	5
		Voltage present, but not +100 vdc (± 2%).	6
		If no voltage, check fuse A1F403 and check for open regulator A1Q401.	
5	Measure ripple frequency at test point A (TP401).	If ripple frequency is 60 Hz, check rectifier diodes A1A6CR401 through A1A6CR404 and A1A6CR408 through A1A6CR411.	
		If ripple frequency is 120 Hz, check filter capacitors A1A6C401, A1A6C405 and A1A7C408.	
6	Measure voltage at test point A (TP401) while varying A1A7R412.	If voltage is variable but cannot be adjusted to +100 vdc, check A1A7V401, A1A7VR401, A1A7VR402, A1A7R411, A1A7C406, A1A7C407 and A1A6CR401 through A1A6CR404.	
		If voltage is not variable, check for shorted or open A1Q401, A1A7Q402, A1A7Q403 and A1A7Q404.	
	+15 VDC SUPPLY		
7	Measure voltage and check for ripple at test point B (TP402).	Voltage is correct (+15 vdc ± 2%), no ripple.	10
		Ripple present.	8

TABLE 4-3. (Continued)

STEP	ACTION	RESULT	NEXT STEP
7 (Cont)		Voltage present but not +15 vdc (± 2%).	9
		If no voltage, check fuse A1F404 and check for open regulator A1Q406 or shorted current limiter A1A7Q408.	
8	Measure ripple frequency at test point B (TP402).	If ripple frequency is 60 Hz, check rectifier diodes A1A6CR413 through A1A6CR416.	
		If ripple frequency is 120 Hz, check filter capacitors A1A6C412 and A1A7C414.	
9	Measure voltage at test point B (TP402) while varying A1A7R423.	If voltage is variable but cannot be adjusted to +15 vdc, check A1A7C413, A1A7R418 and A1A7R422 through A1A7R424.	
		If voltage is not variable, check for shorted or open A1A7Q405, A1Q406, A1A7Q407 and A1A7Q408.	
-12.6 VDC SUPPLY			
10	Measure voltage and check for ripple at test point C (TP403).	If voltage is correct (-12.6 vdc ± 2%) and no ripple is present, power supply is operating properly.	
		Ripple present.	11
		Voltage present but not -12.6 vdc (± 2%).	12
		If no voltage, check fuse A1F405 and check for open regulator A1Q410 or shorted current limiter A1A7Q411.	
11	Measure ripple frequency at test point C (TP403).	If ripple frequency is 60 Hz, check rectifier diodes A1A6CR421 through A1A6CR424.	
		If ripple frequency is 120 Hz, check filter capacitors A1A6C418 and A1A7C420.	
12	Measure voltage at test point C (TP403) while varying A1A7R434.	If voltage is variable but cannot be adjusted to -12.6 vdc, check A1A7C419, A1A7R429 and A1A7R433 through A1A7R435.	
		If voltage is not variable, check for shorted or open A1A7Q409, A1Q410, A1A7Q411 and A1A7Q412.	

NOTES:

1. Primary signal paths weighted. Feedback paths weighted and dashed.

2. The letters cw placed adjacent to the appropriate terminals of a potentiometer indicate maximum clockwise rotation.

3. Letters outside of some circuit blocks indicate transistor elements.

4. Operating control settings for dc voltage measurement conditions:
   POWER switch on

These components not mounted on circuit boards.

Figure 4-3. Low Voltage Power Supply Functional and Servicing Block Diagram (Sheet 1 of 2)

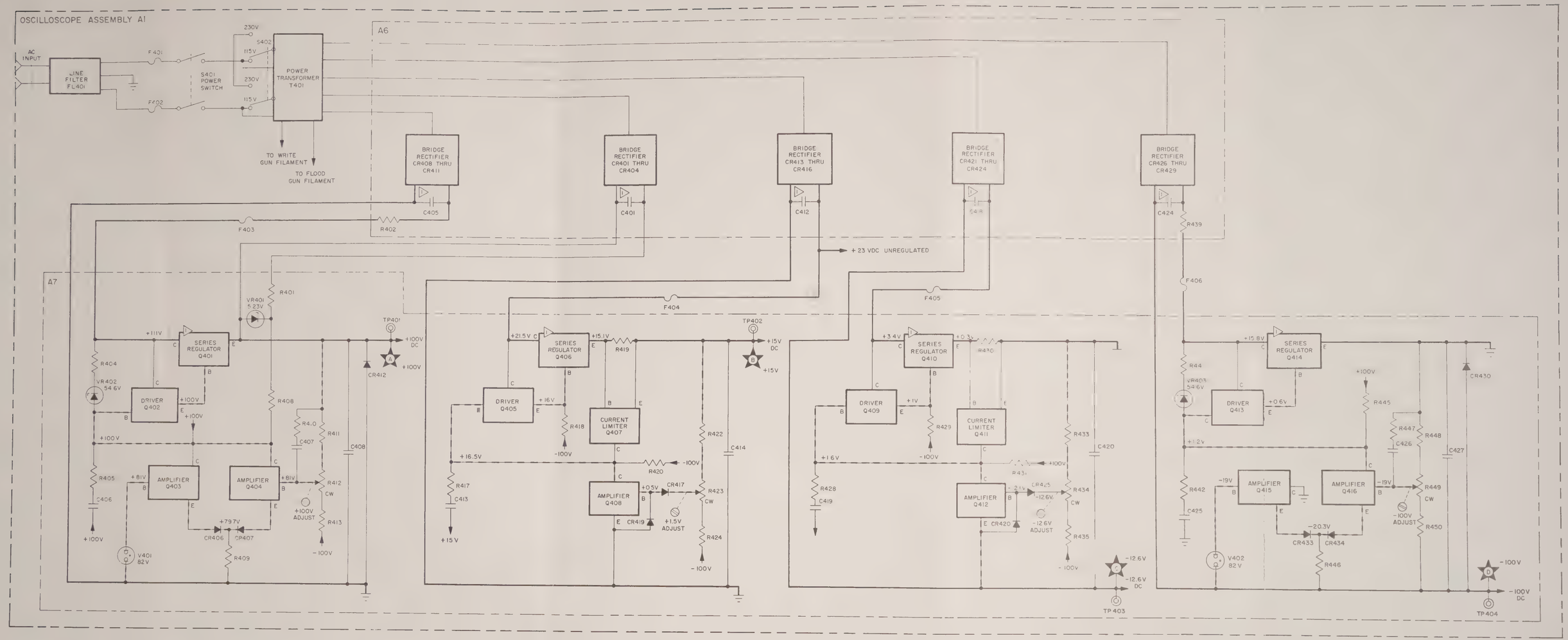


Figure 4-3. Low Voltage Power Supply Functional and Servicing Block Diagram (Sheet 2 of 2)

4-6. HIGH VOLTAGE POWER SUPPLY.

a. HIGH VOLTAGE POWER SUPPLY FUNCTIONAL DESCRIPTION. - The +23 volt unregulated output from the low voltage power supply provides operating power through fuse A1F301 to a transformer-coupled oscillator consisting of A1A5T301 and A1Q304. See figure 4-4. The 50 kHz output of the oscillator is coupled from two secondary windings on A1A5T301 to two half-wave rectifiers and a voltage tripler. The output of half-wave rectifier A1A5CR302 is filtered, compared with the unblanking voltage, and applied to the control grid of the CRT to provide intensity control of the CRT. Intensity limit A1A5R326 adjusts the dc potential on the grid. The -2950 volt output of second half-wave rectifier A1A5CR307 is filtered and applied to the cathode of the CRT and through FOCUS control A1R344 to the focus grid of the CRT. Voltage limiters A1A1V301 and A1A1V302 are connected in series between the cathode and control grid of the CRT to limit the maximum potential difference between these elements to 140 volts in the event one of the elements is shorted to ground or to a positive potential. The voltage tripler consisting of diodes A1A8CR308, A1A8CR309, A1A8CR310 and associated capacitors produces a 9 kv output (approximate) and applies this voltage to the CRT post-accelerator to provide the necessary beam accelerating potential.

The high voltage supply output is regulated by sampling the output of the -2950 volt supply, comparing it to the +100 vdc supply and applying this control voltage through a regulator amplifier (A1A1Q301, A1A1Q302 and A1A1Q303) to control the current through oscillator A1Q304. A voltage increase in the -2950 volt supply causes the regulator to reduce oscillator current and return the output of A1A5T301 to normal. A voltage decrease has the opposite effect on the regulator. Variable resistor A1A1R302 determines the voltage output of the supply. Filter A1A4L301/A1A4C308 provides decoupling to prevent the oscillator from feeding back into the regulator.

b. HIGH VOLTAGE POWER SUPPLY TROUBLE SHOOTING. - The trouble-shooting chart for the high voltage power supply functional section is provided in table 4-4 and the servicing block diagram is shown in figure 4-4. Prior to trouble shooting the high voltage power supply, insure that the low voltage power supply is functioning properly as its' operation is essential to obtain the high voltage output. If the low voltage supplies are functioning properly the oscillator should be checked next. If the oscillator is not functioning (in addition to checking the oscillator and regulator circuit), check for a shorted component in the feedback path (A1A1R305, A1A1C302 and A1A1C303) as this could cause the regulator to cutoff the oscillator. If the oscillator is operating properly, the -2950 volt supply should be checked next because this output controls the regulator. Exercise extreme care when trouble shooting this section of the supply because it contains voltages dangerous to life. When taking voltage measurements in this section, always use a 100:1 divider probe to protect the test instrument. Always keep one hand away from the test setup to prevent a good ground path through the body in the event of accidental contact with these voltages.

When the defective component is located, refer to Section 5 for information concerning repair and replacement. After completing the repair, perform the high voltage adjustment procedure given in Section 5.

c. USEFUL ILLUSTRATIONS. - Illustrations useful in maintaining this functional section are: Figures 4-4, 5-10, 5-13, 5-16, 5-17 and 5-30.

TABLE 4-4. HIGH VOLTAGE POWER SUPPLY TROUBLE SHOOTING

STEP	ACTION	RESULTS	NEXT STEP
1	Check voltage outputs of low voltage power supply at test points A (TP401), B (TP402), C (TP403) and D (TP404). See figure 4-3.	All voltages correct.	2
		If any voltage is not correct, perform the low voltage power supply trouble shooting.	
2	Check Fuse A1F301. See figure 4-4.	Fuse good.	3
		If fuse is defective, check for shorted A1A1Q301, A1A1Q302, A1A1VR302 and A1Q304.	
3	Observe waveform at test point A (collector of A1A1Q304) and compare with that shown in figure 4-4.	Waveform is correct.	4
		Waveform absent.	5

TABLE 4-4. (Continued)

STEP	ACTION	RESULTS	NEXT STEP
	WARNING High voltage is present at test poing B (TP301) and on the secondary side of A1A5T301. Exercise extreme caution while performing step 4.		
4	Using a voltmeter and a 100:1 divider probe, measure high voltage at test point B (TP301).	If voltage is correct (-2950 v ± 10%), check voltage tripler A1A8 and control grid circuitry (A1A5CR302, A1A5C309 through A1A5C311 and A1A5R325 through A1A5R328.	
		If voltage is low or no voltage, check A1A5T301, A1A5CR307 and A1A5C315 through A1A5C317.	
5	Measure voltage at test point A (collector of A1Q304).	If voltage is correct (+4 v ± 10%), check A1A5T301, A1A4C308 and A1A4L301.	
		If voltage is out of tolerance, check for shorted or open A1A1Q301 through A1A1Q303, A1Q304, A1A1VR301, A1A1VR302, A1A1R305, A1A1C302 and A1A1C303.	

4-7. HORIZONTAL AMPLIFIER.

a. HORIZONTAL AMPLIFIER FUNCTIONAL DESCRIPTION. - The input to the horizontal output amplifier (A1A3Q203 through A1A3Q213) is selected by horizontal DISPLAY switch A1S101. See figure 4-5. When A1S101 is set to the INT position, the input to the preamplifier (A1A3Q201 through A1A3-Q202) is grounded and the internal sweep signal from the time base and delay generator is applied to the horizontal output amplifier. When A1S101 is set to the EXT SENS or EXT CAL position, the internal sweep is removed from the horizontal output amplifier and the preamplifier output is applied to the horizontal output amplifier. The input preamplifier is connected to the horizontal EXT INPUT connector. When horizontal DISPLAY A1S101 is in the EXT SENS position, the output of the preamplifier is adjustable by rotating A1S101 between the EXT SENS and EXT CAL positions. In the EXT CAL position, A1R211 is shorted and the output amplitude of the preamplifier is determined only by input amplitude.

The external signal (in EXT CAL or EXT SENS) is coupled to the horizontal preamplifier consisting of A1A3Q201 and A1A3Q202. The preamplifier presents a high impedance to the input signal and provides a low impedance output to drive the horizontal output amplifier. When PHASE BANDWIDTH switch A1A3S202 is switched to the PHASE position, capacitors A1A3C203 and A1A3C204 are added to the circuit to decrease the bandwidth and delay the external signal. This delay compensates for the vertical signal delay (in the dual channel vertical amplifier) and allows more accurate XY comparisons. Capacitor A1A3C203 adjusts delay time. Resistor A1A3R207 is adjusted for 0 vdc across A1A3R211 to eliminate horizontal dc shift as the horizontal DISPLAY is rotated.

The output of the preamplifier, or the internal sweep (depending on the setting of the horizontal DISPLAY switch), is applied to the horizontal output amplifier at the emitter of A1A3Q203. The input signal is summed (in the emitter circuit) with the current established by the HORIZONTAL POSITION controls and the output is coupled through emitter follower A1A3Q204 to differential amplifier A1A3Q206/A1A3-Q207. A1A3Q204 provides a low impedance output to drive A1A3Q206, and A1A3Q205 establishes a constant base voltage on A1A3Q207. The emitter output of A1A3Q206 is coupled through a resistance selected by the horizontal MAGNIFIER A1S203 to drive A1A3-Q207. The resistance selected by A1S203 determines the amount of emitter degeneration and therefore controls the gain of the amplifier. Resistors A1A3R250, A1A3R248 and A1A3R246 provide gain adjustment in the X1, X5 and X10 positions, respectively. A1A3R253 is adjusted to provide equal emitter voltage on A1A3Q206 and A1A3Q207 to prevent horizontal dc shift when switching the horizontal MAGNIFIER. The output of the differential amplifier is coupled from the collectors of A1A3Q206 and A1A3Q207 to complementary feedback amplifiers (A1A3Q208/A1A3Q209/A1A3Q210 and A1A3Q211/A1A3Q212/A1A3Q213) where it is converted to a voltage and applied to the horizontal deflection plates of the CRT. Diodes A1A3CR203 and A1A3CR206

NOTES:

1. Primary signal paths weighted. Feedback paths weighted and dashed.

2. Waveforms recorded with an AN/USM-281 oscilloscope.
   Control settings:
   Sensitivity: 10V/CM
   Sweep time: 5 USEC/CM

3. Explanation of symbols placed at waveforms:
   T = Duration of the portion of waveform indicated
   V = Peak-to-peak voltage

4. The letters cw placed adjacent to the appropriate terminals of a potentiometer indicate maximum clockwise rotation.

5. Operating control settings for dc voltage and waveform measurement conditions:
   POWER switch on

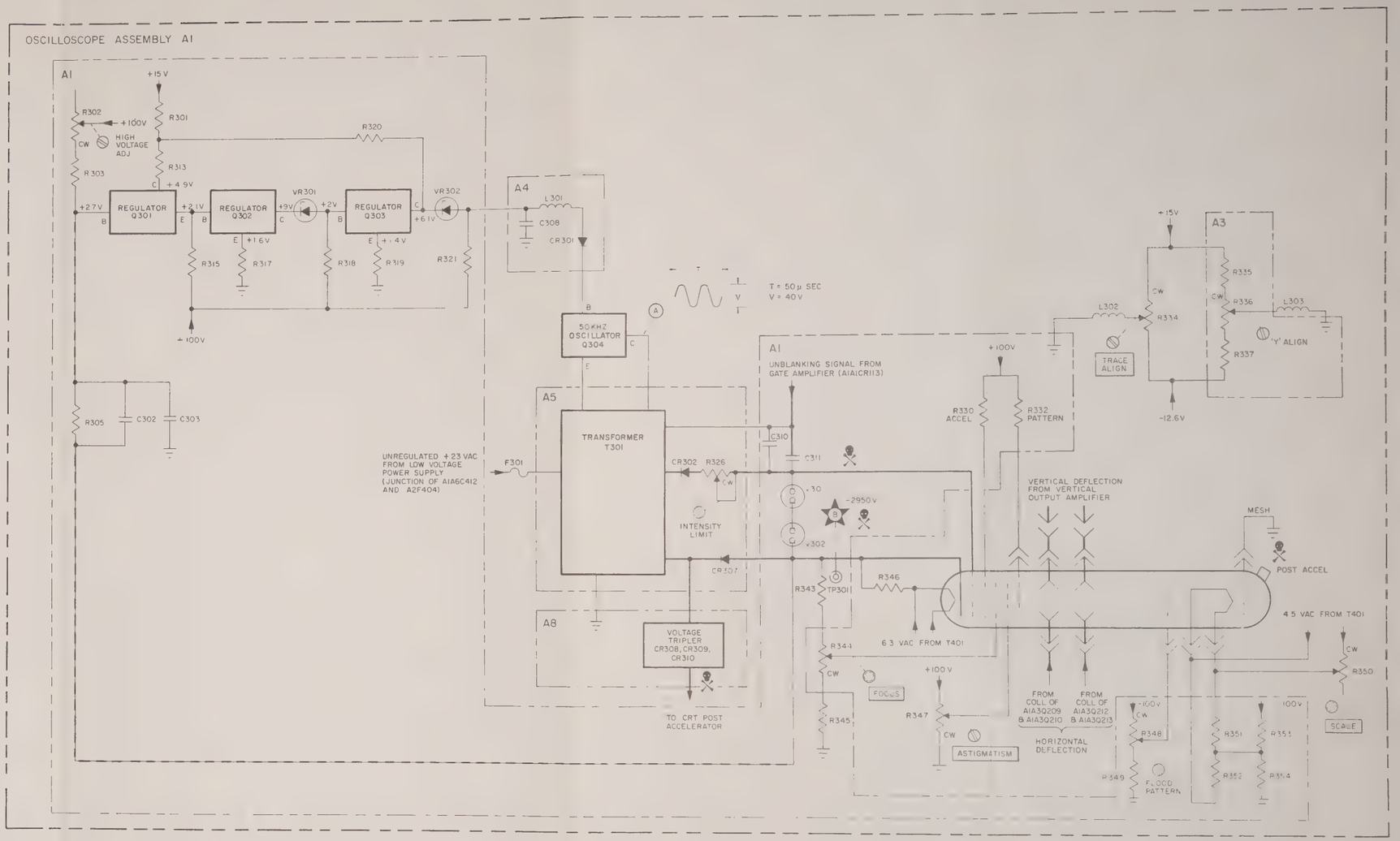


Figure 4-4. High Voltage Power Supply Functional and Servicing Block Diagram

limit the input to the complementary amplifiers to prevent A1A3Q208 and A1A3Q211 (respectively) from saturating. Diodes A1A3CR202/A1A3CR204 and A1A3CR207/A1A3CR208 limit the output to the deflection plates between +6 and +94 volts regardless of input amplitude. The FIND BEAM (when pressed) blocks diode A1A3CR208 and removes one of the differential inputs to the complementary feedback amplifiers to confine the beam to the horizontal limits of the CRT. Negative feedback to the bases of A1A3Q208 and A1A3Q211 produces a very stable gain. A1A3C210 and A1A3C229 adjust the high frequency feedback of each amplifier individually and A1A3C213 adjusts feedback for both. Diodes A1A3CR205 and A1A3CR209 provide temperature compensation for A1A3Q210 and A1A3Q211, respectively.

b. HORIZONTAL AMPLIFIER TROUBLE SHOOTING. - The trouble-shooting chart for the horizontal amplifier functional section is provided in table 4-5 and the servicing block diagram is shown in figure 4-5. A suspected trouble in the horizontal amplifier can sometimes be caused by the time base and delay generator. Before trouble shooting the horizontal amplifier, set the oscilloscope controls to obtain an internal sweep from the main time base generator (refer to Section 3) and observe the CRT. If a trace cannot be obtained, set the horizontal DISPLAY TO EXT CAL and observe the CRT while rotating the HORIZONTAL POSITION controls. If the HORIZONTAL POSITION controls are able to move the spot off the screen on both the left and right sides, the trouble is probably in the time base and delay generator. Further check the horizontal amplifier by applying a signal from the CALIBRATOR 10V output to the horizontal EXT INPUT. If a trace approximately 10 cm in width appears and can be centered, the trouble is not in the horizontal amplifier.

If the horizontal amplifier operates properly with the horizontal DISPLAY in INT but does not operate in the external positions, the trouble is in the horizontal preamplifier circuit of this functional section.

When it has been determined that the trouble is in thr horizontal amplifier functional section, perform the procedures in table 4-5 to isolate the defective component. The horizontal section contains a decoupling filter network (see figure 4-5) that should also be checked while trouble shooting this section as a low voltage caused by a defective filter coil or capacitor would affect the operation of this section. When the defective component is located and the repair completed, perform the horizontal amplifier adjustment procedures in Section 5 to return this section to a functional condition.

c. USEFUL ILLUSTRATIONS. - Illustrations useful in maintaining this functional section are: Figures 4-5, 5-15, and 5-30.

TABLE 4-5. HORIZONTAL AMPLIFIER TROUBLE SHOOTING

STEP	ACTION	RESULTS	NEXT STEP
1	Set oscilloscope controls as follows: Set horizontal MAGNIFIER to XI. Set horizontal DISPLAY to EXT CAL. Set horizontal EXT INPUT to AC. Adjust HORIZONTAL POSITION to center spot horizontally.	Centered spot.	5
		Spot moves, but will not center.	2
		If spot will not move horizontally, check transistors A1A3Q203 through A1A3Q207. Also check the decoupling filter network (see figure 4-5).	
2	Momentarily connect a test lead from collector of A1A3Q206 to collector of A1A3Q207 and observe CRT. See figure 4-5.	Spot moves near center.	3
		If spot does not move near center, check transistors A1A3Q208 through A1A3Q213 and diodes A1A3CR202, A1A3CR204, A1A3CR207 and A1A3CR208.	
3	Momentarily connect a test lead from the base of A1A3Q204 to the base of A1A3Q205 and observe CRT.	Spot does not move near center.	4
		If spot moves near center, check A1A3Q201, A1A3Q202, and A1A3Q203.	
4	Momentarily connect a test lead from the base of A1A3Q206 to the base of A1A3Q207 and observe CRT.	If spot moves near center, check A1A3Q204 and A1A3Q205.	

TABLE 4-5. (Continued)

STEP	ACTION	RESULTS	NEXT STEP
4 (Cont)		If spot does not move near center, check A1A3Q206 and A1A3Q207.	
5	Connect the Calibrator 10V output to horizontal EXT INPUT and center trace. Observe waveform and dc voltage at test point D and compare with that shown in figure 4-5.	Waveform and voltage are correct.	6
		Waveform and/or voltage are incorrect.	7
6	Observe waveform and dc voltage at test point C and compare with that shown in figure 4-5.	If waveform and voltage are correct, check CRT.	
		If waveform and/or voltage are incorrect, check A1A3Q208, A1A3Q209, A1A3Q210, and associated components; and A1A3CR202 and A1A3CR204.	
7	Observe waveform and dc voltage at test point C and compare with that shown in figure 4-5.	Waveform and/or voltage are incorrect.	8
		If waveform and voltage are correct, check A1A3Q211, A1A3Q212, A1A3Q213, and associated components; and A1A3CR207 and A1A3CR208.	
8	Observe waveform and dc voltage at test point B and compare with that shown in figure 4-5.	Waveform and/or voltage are incorrect.	9
		If waveform and voltage are correct, check A1A3Q204 through A1A3Q207 and associated components.	
9	Observe waveform and dc voltage at test point A and compare with that shown in figure 4-5.	If waveform and voltage are correct, check A1A3Q202, A1A3Q203, A1S101 and A1S202.	
		If waveform and/or voltage are incorrect, check A1A3Q201, A1A3CR201 and A1S201.	

4-8. GATE AMPLIFIER.

a. GATE AMPLIFIER FUNCTIONAL DESCRIPTION. - The inputs to the gate amplifier are the unblanking gate from the time base and delay generator, the chopped blanking signal from the dual channel vertical amplifier, and a Z-AXIS signal from an external input connector. See figure 4-6. These three signals may be present singly or simultaneously depending on control settings and inputs applied. The inputs to the gate amplifier are combined in the low impedance emitter circuit of A1A1Q101 with a current established by the INTENSITY, FIND BEAM, and horizontal DISPLAY controls. The FIND BEAM (when pressed) shunts the adjustable INTENSITY potentiometer to increase emitter current and produce an intensified beam. Setting the horizontal DISPLAY to the external positions supplies additional current from the -100 vdc supply to brighten the beam. The output of A1A1Q101 is coupled to complimentary feedback amplifier A1A1Q102 through A1A1Q104 where it is converted to a voltage and coupled (through the high voltage supply) to the control grid of the CRT. The output of A1A1Q103 and A1A1Q104 is also differentiated by A1A1R128 and A1A1R130, converted to a low impedance output by A1A1Q105 and clipped by A1A1CR111 to provide a negative trigger pulse to the multivibrator in the dual channel vertical amplifier. A large negative feedback signal is coupled from the collectors of A1A1Q103 and A1A1Q104 to the base of A1A1Q102 to provide a stable gain. Capacitors A1A1C110 and A1A1C113 in the feedback path adjust high frequency response. Diode A1A1CR108 provides temperature compensation for A1A1Q103. Diodes A1A1CR109 and A1A1CR110 protect A1A1Q103 and A1A1Q104 from voltage breakdown. Diodes

NOTES:

1. Primary signal paths weighted. Feedback paths weighted and dashed.

2. Waveforms recorded with an AN/USM-281 oscilloscope.
   Control settings:
   Sensitivity: .05V/CM, 1V/CM, 2V/CM, 10V/CM
   Sweep time: .2MS/CM

3. Explanation of symbols placed at waveforms:
   T = Duration of the portion of waveform indicated
   V = Peak-to-peak voltage

4. The letters cw placed adjacent to the appropriate terminals of a potentiometer indicate the maximum clockwise rotation.

5. Operating control settings for dc voltage measurement conditions:
   INTENSITY to normal setting
   Horizontal MAGNIFIER to X1
   Horizontal EXT INPUT to AC
   Vertical DISPLAY to A
   SCALE fully ccw
   Horizontal DISPLAY to EXT CAL
   POSITION to center trace

6. Operating control settings for waveform measurement conditions:
   INTENSITY to normal setting
   Horizontal MAGNIFIER to X1
   Horizontal EXT INPUT to AC
   Vertical DISPLAY to A
   SCALE fully ccw
   Horizontal DISPLAY to EXT CAL
   POSITION to center trace
   Connect oscilloscope CALIBRATOR 10V output to channel A EXT INPUT.

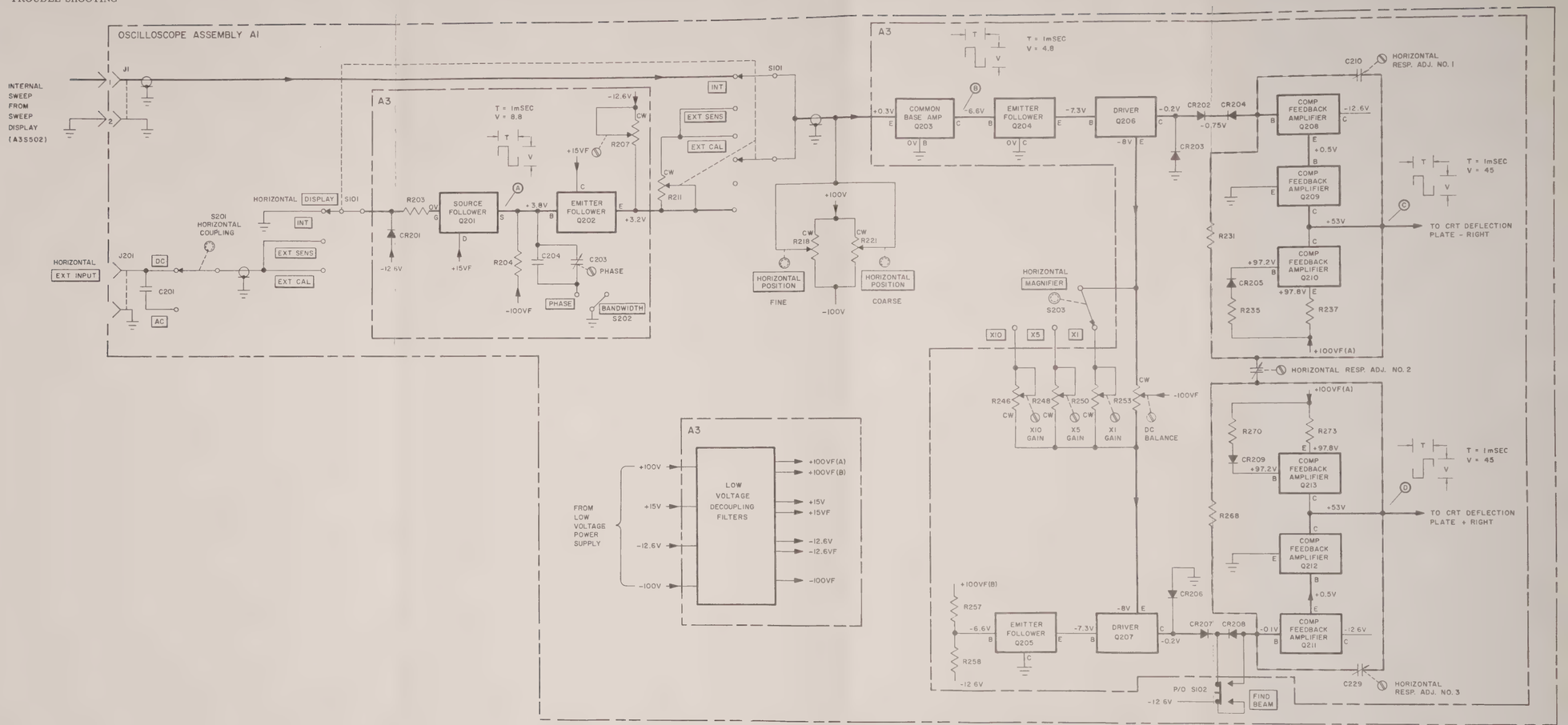


Figure 4-5. Horizontal Amplifier Functional and Servicing Block Diagram

A1A1CR112 and A1A1CR113 are in series with the output of the amplifier to block positive pulses from the high voltage supply.

b. GATE AMPLIFIER TROUBLE SHOOTING. - The trouble-shooting chart for the gate amplifier functional section is provided in table 4-6 and the servicing block diagram is shown in figure 4-6. The gate amplifier controls intensity of the CRT and can cause two types of trouble if a malfunction occurs in this functional section. The first type of trouble is a lack of intensity or a dark screen and is hard to distinguish from troubles in the high voltage supply. If the high voltage supply has been checked and is functioning properly, the gate amplifier should be checked thoroughly before replacing the CRT. The second type of trouble is the appearance or retrace lines when operating in the internal sweep mode and visible switching transients when operating in the dual channel chopped mode. This condition is readily apparent and is usually accompanied by increased intensity with a lack of intensity control and the inability to obtain a dual trace in either of the dual channel alternate modes. If intensity is normal and can be controlled with the intensity control but the oscilloscope will not produce dual traces in the alternate mode, check the emitter follower and clipper section (A1A1Q105) in addition to checking the multivibrator in the dual channel vertical amplifier.

When the trouble has been isolated to the gate amplifier functional section, perform the procedures in table 4-6 to isolate the defective component. In addition to these procedures, the decoupling filter network (figure 4-6) in the gate amplifier functional section should be checked while trouble shooting this functional section. When the defective component is located and the repair is completed, check the gate amplifier response and intensity limit adjustment in accordance with Section 5.

c. USEFUL ILLUSTRATIONS. - Illustrations useful in maintaining this functional section are: Figures 4-6, 5-13 and 5-30.

TABLE 4-6. GATE AMPLIFIER TROUBLE SHOOTING

STEP	ACTION	RESULTS	NEXT STEP
1	Set oscilloscope controls as follows: Set horizontal DISPLAY to EXT CAL. Set vertical DISPLAY to A. Rotate HORIZONTAL POSITION fully cw to move spot off screen. Adjust INTENSITY to produce +30 vdc on the collector of A1A1Q103. Connect a 100 kHz, 5 v peak-to-peak, negative square wave with a rise time of less than 30 nsec to the Z-AXIS input connector. Observe waveform at test point A and compare with that shown in figure 4-6. NOTE To obtain voltages shown in figure 4-6, the Z-AXIS input must be removed and INTENSITY must be adjusted to produce +57 vdc on the collector of A1A1Q103.	Waveform is correct, and spot on CRT was normal (prior to adjusting HORIZONTAL POSITION off screen); but vertical amplifier will not function in the dual channel alternate modes.	2
		If waveform and voltage are correct but spot can not be obtained when Z-AXIS input is removed, check A1A1CR112, A1A1CR113 and the CRT.	
		If waveform is incorrect, check A1A1Q101 through A1A1Q104, A1A1CR101 through A1A1CR104 and A1A1CR108 through A1A1CR110.	
2	Observe waveform at test point B and compare with that shown in figure 4-6.	If waveform is correct, check A1J1 pin 6 and multivibrator in dual channel vertical amplifier.	
		If waveform is incorrect, check A1A1C116, A1A1Q105 and A1A1CR111.	

NOTES:

1. Primary signal paths weighted. Feedback paths weighted and dashed.

2. Waveform recorded with an AN/USM-281 oscilloscope
   Control settings:
   Sensitivity: 1V/CM, 5V/CM
   Sweep time: 2 USEC/CM

3. Explanation of symbols placed at waveform.
   T=Duration of the portion of waveform indicated
   V=Peak-to-peak voltage

4. The letters cw placed adjacent to the appropriate terminals of a potentiometer indicate the maximum clockwise rotation.

5. Operating control settings for dc voltage measurement conditions:
   Horizontal DISPLAY to EXT CAL
   Vertical DISPLAY to A
   Adjust INTENSITY for +57 vdc at collector of A1A1Q103.

6. Operating control settings for waveform measurement conditions:
   Horizontal DISPLAY to EXT CAL
   Vertical DISPLAY to A
   Rotate HORIZONTAL POSITION fully cw to move spot off screen
   Adjust INTENSITY for +57 vdc at collector of A1A1Q103
   Connect a 100 kHz 5v pk-pk, negative square wave with a rise time of less than 30 nsec to Z-AXIS INPUT.

Figure 4-6 Gate Amplifier Functional and Servicing Block Diagram (Sheet 1 of 2)

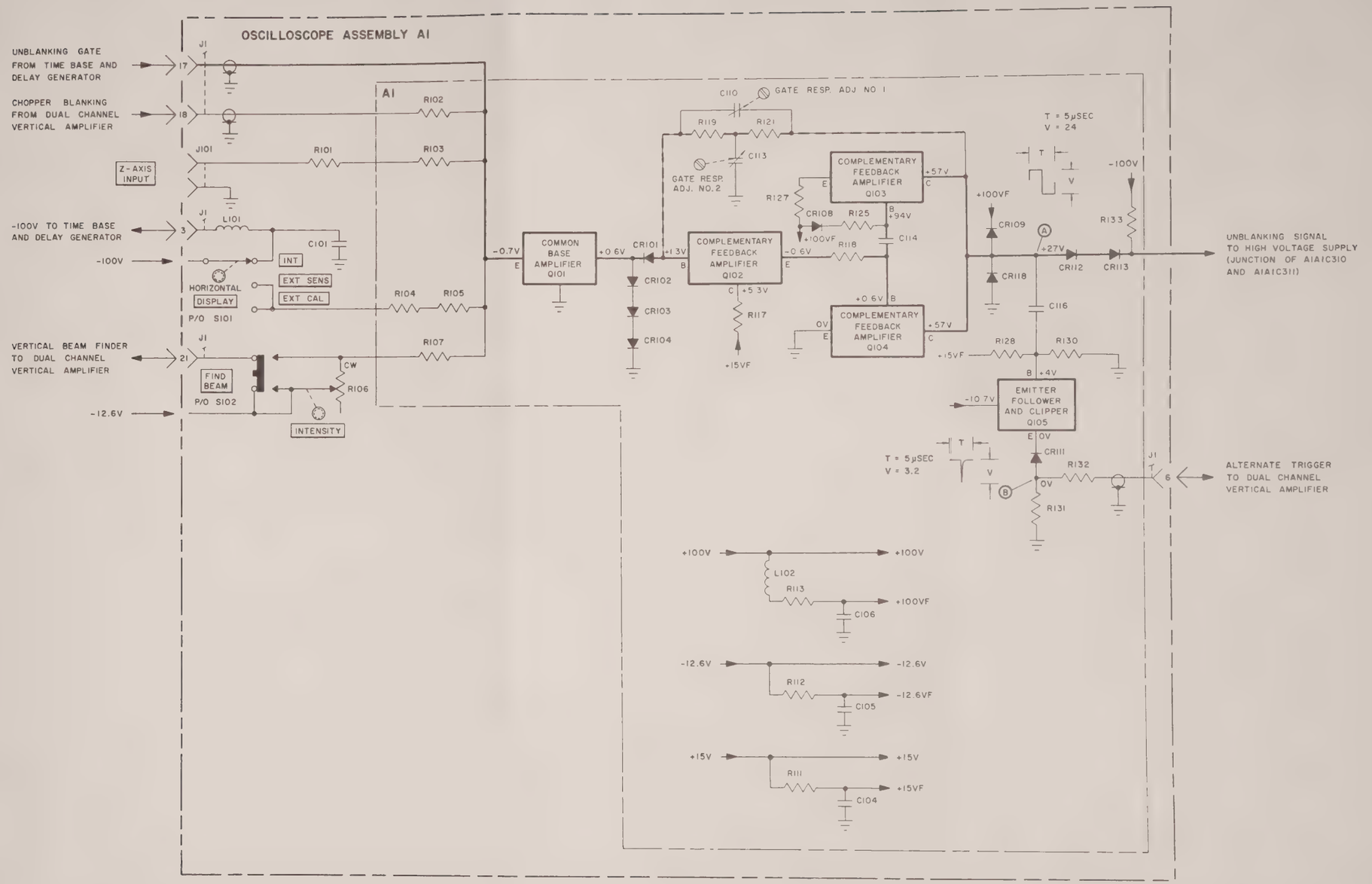


Figure 4-6. Gate Amplifier Functional and Servicing Block Diagram (Sheet 2 of 2)

4-9. CALIBRATOR.

a. CALIBRATOR FUNCTIONAL DESCRIPTION. - The calibrator output signal is produced by a free-running multivibrator consisting of A1A1Q106 and A1A1Q107. See figure 4-7. The multivibrator is RC coupled and oscillates at a frequency of 1 kHz. Two outputs, taken from a voltage divider consisting of A1A1R145, A1A1R144 and A1A1R143 are coupled to front-panel connectors to provide 250 mv and 10 v outputs. Diode A1A1CR115 isolates the negative discharge of capacitor A1A1C122 from the output when A1A1Q107 cuts off to provide a faster rise time. Diodes A1A1CR116 and A1A1CR117 protect the transistors from voltage breakdown and filter A1A1L105/A1A1C123 isolates the multivibrator from the -100 vdc supply.

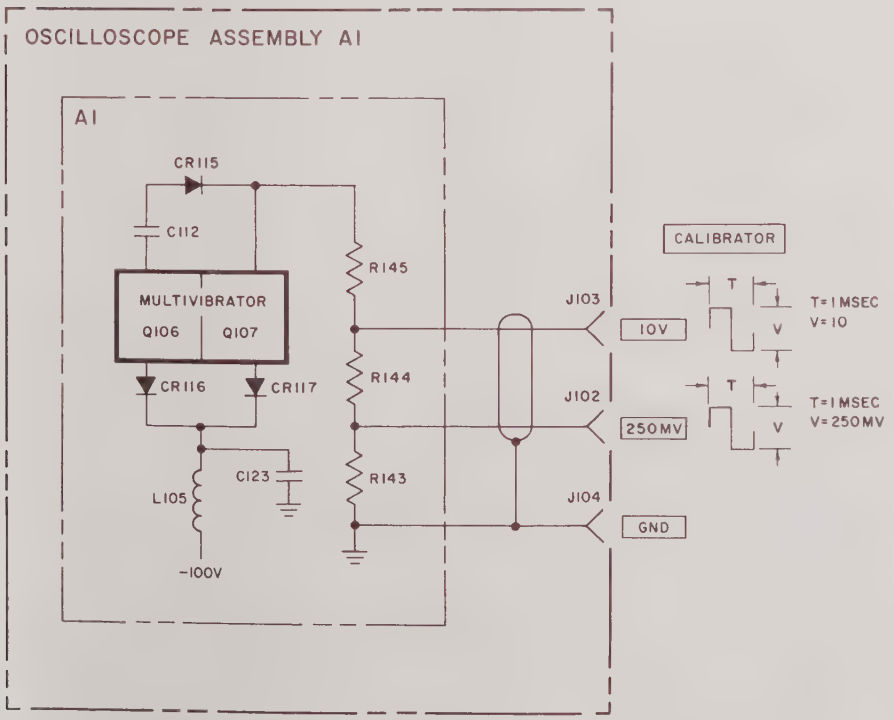
b. CALIBRATOR TROUBLE SHOOTING. - Because of the simplicity of this functional section no trouble-shooting chart is provided. If a trouble exists in this functional section use the servicing block diagram (figure 4-7) and the schematic diagram (figure 5-30) to aid in isolating the malfunction. If the multivibrator is operating but is off frequency, check A1A1C121, A1A1C122 and resistors A1A1R137 through A1A1R142. If the multivibrator is operating but the output amplitude is incorrect, check resistors A1A1R143, A1A1R144 and A1A1R145. If the multivibrator is not operating, check diodes A1A1CR115 through A1A1CR117 and transistors A1A1Q106 and A1A1Q107.

c. USEFUL ILLUSTRATIONS. - Illustrations useful in maintaining this functional section are: Figures 4-7, 5-13 and 5-30.

4-10. MAIN AND DELAYED SWEEP AND MAIN AND DELAYED GATE OUTPUT AMPLIFIERS.

a. MAIN AND DELAYED SWEEP AND MAIN AND DELAYED GATE OUTPUT AMPLIFIERS FUNCTIONAL DESCRIPTION. - The main and delayed sweep and main and delayed gate output amplifiers functional section consists of four transistor amplifiers (A1A2Q108 through A1A2Q111) and their associated components. See figure 4-8. The four inputs to these amplifiers are the main sweep, the delayed sweep, the main gate, and the delayed gate signals from the time base and delay generator. Output amplifiers A1A2Q108 through A1A2Q111 are emitter followed to isolate the high impedance inputs from the low impedance outputs. The outputs are coupled to four rear-panel connectors to provide connection points for external equipment. Operating voltage to the amplifiers is filtered by A1A2L107, A1A2L108, A1A2R161, A1A2R162, A1A2C127 and A1A2C128.

b. MAIN AND DELAYED SWEEP AND MAIN AND DELAYED GATE OUTPUT AMPLIFIERS TROUBLE SHOOTING. - The trouble-shooting chart for the main and delayed sweep and main and delayed gate output amplifiers functional section is provided in table 4-7 and the servicing block diagram is shown in figure 4-8. These four output amplifiers have no internal function and a malfunction in one of these amplifiers is not



NOTES:

1. Waveforms recorded with an AN/USM-281 oscilloscope.
   Control settings:
   Sensitivity: .05V/CM, 2V/CM
   Sweep time: .2MS/CM
2. Explanation of symbols placed at waveforms:
   T=Duration of the portion of waveform indicated
   V=Peak-to-peak voltage
3. Operationg control settings for waveform measurement conditions:
   POWER switch on

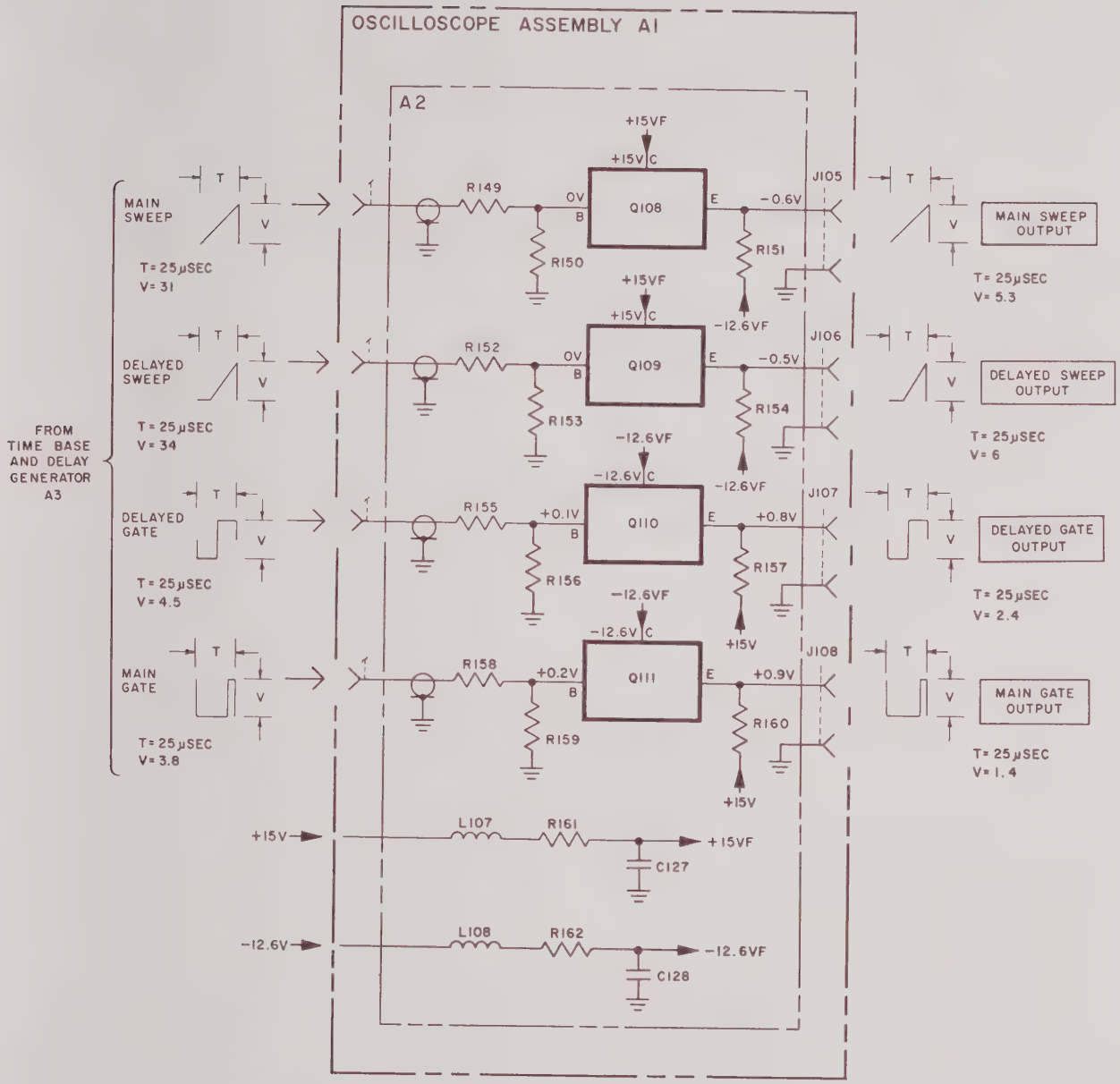
Figure 4-7. Calibrator Functional and Servicing Block Diagram

readily apparent because it would not normally affect oscilloscope operation. (An exception would be a short in one of the amplifiers that loads down the internal signal.) To determine if these amplifiers are operating properly, the outputs at the four rear-panel connectors should be monitored periodically with a test oscilloscope. If the output observed with the test oscilloscope is incorrect and the AN/USM-281 Oscilloscope is functioning properly, perform the procedures in table 4-7 to isolate the defective component.

c. USEFUL ILLUSTRATIONS. - Illustrations useful in maintaining this functional section are: Figures 4-8, 5-14 and 5-30.

TABLE 4-7. MAIN AND DELAYED SWEEP AND MAIN AND DELAYED GATE OUTPUT AMPLIFIERS TROUBLE SHOOTING

STEP	ACTION	RESULTS	NEXT STEP
1	Set oscilloscope controls as follows: Set horizontal DISPLAY to INT. Set sweep display to MAIN. Set main TIME/CM to 2 USEC. Set SWEEP MODE to AUTO. Set MAIN VERNIER to CAL. Set delayed TIME/CM to 1 USEC. Set delayed trigger source to AUTO. Set DELAYED VERNIER to CAL. Set CM DELAY to 5.00. Observe waveform at MAIN SWEEP OUTPUT and compare with that shown in figure 4-8.	Waveform is correct.	2
		If waveform is incorrect, check A1A2Q108 and check filters A1A2L107, A1A2L108, A1A2R161, A1A2R162, A1A2C127 and A1A2C128.	
2	Observe waveform at DELAYED SWEEP OUTPUT and compare with that shown in figure 4-8.	Waveform is correct.	3
		If waveform is incorrect, check A1A2Q109.	
3	Observe waveform at DELAYED GATE OUTPUT and compare with that shown in figure 4-8.	Waveform is correct.	4
		If waveform is incorrect, check A1A2Q110.	
4	Observe waveform at MAIN GATE OUTPUT and compare with that shown in figure 4-8.	If waveform is correct, output amplifiers are functioning properly.	
		If waveform is incorrect, check A1A2Q111.	



NOTES:

1. Waveforms recorded with an AN/USM-281 oscilloscope.
   Control settings:
   Sensitivity: 5V/CM
   Sweep Time: 5 US/CM

2. Explanation of symbols placed at waveforms:
   T=Duration of the portion of waveform indicated
   V=Peak-to-peak voltage

3. Operating control settings for waveform measurement conditions:
   Horizontal DISPLAY to INT
   Sweep display to MAIN
   SWEEP MODE to AUTO
   MAIN VERNIER to CAL
   Main TIME/CM to 2 USEC
   DELAYED VERNIER to CAL
   Delayed TIME/CM to 1 USEC
   Delayed trigger source to AUTO
   CM DELAY to 5.00

Figure 4-8. Main and Delayed Sweep and Main and Delayed Gate Output Amplifiers Functional and Servicing Block Diagram

4-11. DUAL CHANNEL VERTICAL AMPLIFIERS AND ATTENUATORS.

a. DUAL CHANNEL VERTICAL AMPLIFIERS AND ATTENUATORS FUNCTIONAL DESCRIPTION. - The channel A and channel B amplifier and attenuator circuitry is almost identical. Therefore, only the channel A circuitry and the differences between channels are explained.

An input signal applied to channel A INPUT connector A2J101 is applied through input coupling switch A2S101 to the channel A attenuator. See figure 4-9. When A2S101 is set to the DC position, the input signal is applied directly to the attenuator. In the AC position, the input signal is applied to the attenuator through A2C101 to remove the dc component of the signal. The attenuator consists of seven voltage dividers separated into two sections. The first section consists of dividers with a ratio of 1:1, 10:1, 100:1 and 1000:1. The second section contains dividers with ratios of 1:1, 2:1 and 4:1. Each divider in the first section is used in turn with each divider in the second section to provide 12 ranges of attenuation in a 5, 1, 2 sequence. The variable capacitors in the attenuators are adjusted to maintain a constant input capacitance on all ranges and to provide frequency compensation.

The output of the attenuator is coupled through A2A3Q101 and A2A3Q103 to a cascode amplifier consisting of A2A3Q301 through A2A3Q304. Source follower A2A3Q101 presents a high impedance to the input signal and emitter follower A2A3Q103 provides a low impedance output to the cascode amplifiers. Transistors A2A3Q102 and A2A3Q104 provide temperature compensation for A2A3Q101 and A2A3Q103 (respectively). A2R124 sets the quiescent dc level of the differential amplifier. Diodes A2A3CR101 and A2A3CR102 protect A2A3Q101 from overvoltages. Cascode amplifier A2A3Q301 through A2A3Q304 converts the unbalanced, single-ended input signal into a balanced push-pull output. A2A3R303 sets the operating level of the amplifier and A2A3C301 adjusts pulse response. Vernier VOLTS/CM A2R309 and CAL adjust A2A3R308 determine amplifier gain by shunting current away from the input of A2A3Q303 and A2A3Q304. Vernier balance adjust A2A3R317 compensates for differences in gain between A2A3Q303 and A2A3Q304 and is adjusted for no vertical trace shift when vernier VOLTS/CM A2R309 is rotated.

The balanced, push-pull output of the cascode amplifier is applied through A2A3T301 and emitter followers A2A3Q305 and A2A3Q306 to polarity diodes A2A3CR302 through A2A3CR309. Transformer A2A3T301 and capacitors A2A3C305 and A2A3C306 provide improved pulse response. POLARITY switch A2S301 controls the polarity diodes and determines the polarity presentation of the waveform. Setting A2S301 to +UP blocks diodes A2A3CR302 through A2A3CR305 and turns A2A3CR306 through A2A3CR309 on. The input signal is then coupled from A2A3Q305 to A2A3Q307 and from A2A3Q306 to A2A3Q308. Setting A2S301 to -UP blocks diodes A2A3CR306 through A2A3CR309 and allows diodes A2A3CR302 through A2A3CR305 to couple the output of A2A3Q305 to A2A3Q308 and the output of A2A3Q306 to A2A3Q307. (In the Channel B circuit the output of the polarity diodes is also coupled to the sync amplifier.) A2R338 adjusts the dc input level of A2A3Q307 and A2A3Q308 and controls the vertical position of the trace. A2A3C316 and A2A3R348 adjust pulse response. The output of A2A3Q307 and A2A3Q308 is applied to the gate control circuit consisting of diodes A2A3CR313 through A2A3CR316. The gating diodes are controlled by the multivibrator. When the multivibrator applies a positive signal to the anodes of A2A3CR313 and A2A3CR314, diodes A2A3CR315 and A2A3CR316 are cut off and the output of the channel A amplifier is blocked. When the multivibrator applies a negative signal to the anodes of A2A3CR313 and A2A3CR314, these diodes are blocked and the output of the channel A amplifier passes through A2A3CR315 and A2A3CR316 to the delay line and to the sync amplifier. A2R354 adjusts dc balance between the channel A and B amplifiers.

The output of the gate control circuit is delayed 160 nsec by delay line A2DL501 and is coupled to the output amplifier consisting of A2A3Q501 through A2A3Q512. The output amplifier boosts the input signal and provides a high level output signal to drive the vertical deflection plates of the CRT. Variable capacitors A2A3C507 and A2A3C510 adjust pulse response. FIND BEAM switch A1S102 (in the oscilloscope assembly) supplies -12.6 vdc through A2A3R529 and A2A3R530 to A2A3Q509 and A2A3Q510. Pressing the FIND BEAM removes this voltage source, and applies the -12.6 vdc to these transistors through A2A3R528. This reduces the current available to A2A3Q509 and A2A3Q510 and limits the maximum deflection voltage to confine the trace to the vertical limits of the CRT. Vertical magnifier A2A3S1101 controls the gain of A2A3Q509 and A2A3Q510. When A2A3S1101 is set to X5, relay A2A3K1101 closes and decreases the emitter resistance of A2A3Q509 and A2A3Q510. This decreases the amount of emitter degeneration and increases the gain of this stage by a factor of five. Diodes A2A3CR501 and A2A3CR502 provide high frequency compensation for A2A3Q509 and A2A3Q510.

b. DUAL CHANNEL VERTICAL AMPLIFIERS AND ATTENUATORS TROUBLE SHOOTING. - The trouble-shooting chart for the dual channel vertical amplifiers and attenuators functional section is provided in table 4-8 and the servicing block diagram is shown in figure 4-9. A malfunction can usually be isolated to this section by setting the oscilloscope controls for alternate dual trace operation (refer to Section 3), connecting the CALIBRATOR 10V output to the channel A and B input connectors and observing the CRT. If a normal display appears on one channel and an abnormal display appears on the other channel, the problem is probably in the appropriate channel ahead of the delay line and output amplifier. (A problem in the multivibrator functional section could also cause this condition.) The appropriate VOLTS/CM can then be manipulated to determine if the problem is in the attenuator or between the attenuator and delay line. Rotating the POSITION and vernier VOLTS/CM controls can also help to localize the malfunction.

If a vertical display cannot be obtained on either channel, the problem is probably in the output amplifier (A2A3Q501 through A2A3Q512) or the connections to the CRT. The vertical output connections to the CRT (A2P2) are mounted on an etched circuit

board that makes contact with the oscilloscope assembly CRT connector (A1J2) when the vertical plug-in unit is inserted into the oscilloscope assembly. Inspect this etched circuit board and the oscilloscope assembly closely to insure that they are making good electrical contact.

When the trouble is isolated to this functional section, perform the procedures in table 4-8 to isolate the defective component. After completing the repair of this section, perform the dual channel vertical amplifier adjustments in Section 5 to restore this section to an operational condition.

c. USEFUL ILLUSTRATIONS. - Illustrations useful in maintaining this functional section are: Figures 4-9, 5-20, 5-21, 5-22, 5-23 and 5-31.

TABLE 4-8. DUAL CHANNEL VERTICAL AMPLIFIERS AND ATTENUATORS TROUBLE SHOOTING

STEP	ACTION	RESULTS	NEXT STEP
1	Set oscilloscope controls as follows: Set horizontal DISPLAY to INT. Set horizontal MAGNIFIER to X1. Set vertical DISPLAY to A. Set POLARITY (A and B) to +UP. Set VOLTS/CM (A and B) to 2. Set vernier VOLTS/CM (A and B) to CAL. Set input coupling (A and B) to AC. Set time base and delay generator contorls to produce main sweep. Adjust A POSITION to center trace. Connect CALIBRATOR 10V output to channel A INPUT. Observe waveform at test point A and compare with that shown in figure 4-9. NOTE To obtain voltages shown in figure 4-9, the channel A and B input coupling switches must be set to GND.	Waveform is correct.	2
		If waveform is incorrect, check A2A3Q101 through A2A3Q104, A2A3CR101, A2A3CR102 and attenuator A2S102 (A2A1). Also check filtered voltages.	
2	Observe waveform at test point B and compare with that shown in figure 4-9.	Waveform is correct.	3
		If waveform is incorrect, check A2A3Q301 through A2A3Q304 and A2A3VR301.	
3	Observe waveform at test point C and compare with that shown in figure 4-9.	Waveform is correct.	4
		If waveform is incorrect, check A2A3Q305, A2A3Q306 and A2A3CR302 through A2A3CR309.	

TABLE 4-8. (Continued)

STEP	ACTION	RESULTS	NEXT STEP
4	Observe waveform at test point G and compare with that shown in figure 4-9.	Waveform is correct.	5
		If waveform is incorrect, check A2A3Q307, A2A3Q308, A2A3CR313 through A2A3CR316 and multivibrator functional section.	
5	Set vertical DISPLAY to B. Disconnect CALIBRATOR 10V output from A INPUT and connect to B INPUT. Observe waveform at test point D and compare with that shown in figure 4-9.	Waveform is correct.	6
		If waveform is incorrect, check A2A3Q201 through A2A3Q204, A2A3CR201, A2A3CR202 and attenuator A2S202 (A2A2).	
6	Observe waveform at test point E and compare with that shown in figure 4-9.	Waveform is correct.	7
		If waveform is incorrect, check A2A3Q401 through A2A3Q404 and A2A3VR401.	
7	Observe waveform at test point F and compare with that shown in figure 4-9.	Waveform is correct.	8
		If waveform is inoorrect, check A2A3Q405, A2A3Q406 and A2A3CR402 through A2A3CR409.	
8	Observe waveform at test point G and compare with that shown in figure 4-9.	Waveform is correct.	9
		If waveform is incorrect, check A2A3Q407, A2A3Q408, A2A3CR413 through A2A3CR416 and multivibrator functional section.	
9	Observe waveform at test point H and compare with that shown in figure 4-9.	Waveform is correct.	10
		If waveform is incorrect, check A2A3Q501, A2A3Q502 and delay line A2DL501.	
10	Observe waveform at test point J and compare with that shown in figure 4-9.	Waveform is correct.	11
		If waveform is incorrect, check A2A3Q503 through A2A3Q506.	
11	Observe waveform at test point K and compare with that shown in figure 4-9.	If waveform is correct, the attenuators and amplifiers are functioning properly. Check the CRT and CRT connections.	
		If waveform is incorrect, check A2A3Q507 through A2A3Q512, A2A3C501, A2A3CR502, A2A3VR501 and A2A3C512.	

NOTES:

1. Primary signal paths weighted.

2. Waveforms recorded with an AN/USM-281 oscilloscope.
   Control settings:
   Sensitivity: .05V/CM, .5V/CM, 1V/CM
   Sweep time: .2MS/CM

3. Explanation of symbols placed at waveforms:
   T = Duration of the portion of waveform indicated
   V = Peak-to-peak voltage

4. The letters cw placed adjacent to the appropriate terminals of a potentiometer indicate the maximum clockwise rotation.

5. Operating control settings for dc voltage measurement conditions:
   Horizontal DISPLAY to INT
   Horizontal MAGNIFIER to X1
   Vertical DISPLAY to A
   POLARITY (both channels) to +UP
   VOLTS/CM (both channels) to 1
   Vernier VOLTS/CM (both channels) to CAL
   Input coupling (both channels) to GND
   A POSITION to center trace

6. Operating control settings for waveform measurement conditions:
   Horizontal DISPLAY to INT
   Horizontal MAGNIFIER to X1
   Vertical DISPLAY to A
   POLARITY (both channels) to +UP
   VOLTS/CM (both channels) to 2
   Vernier VOLTS/CM (both channels) to CAL
   Input coupling (both channels) to GND
   A POSITION to center trace
   Connect CALIBRATOR 10V output to channel A and B INPUT connectors.

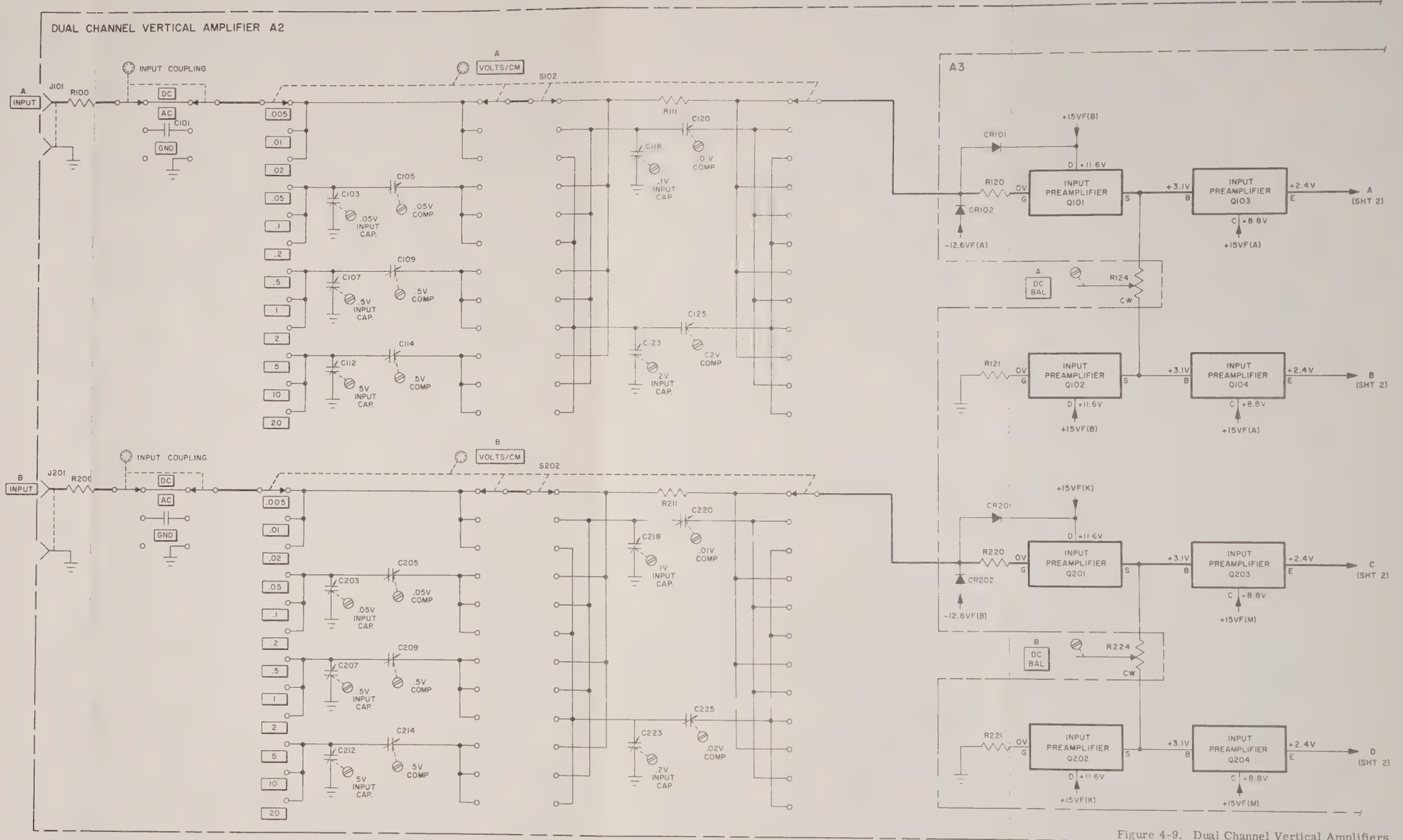


Figure 4-9. Dual Channel Vertical Amplifiers and Attenuators Functional and Servicing Block Diagram (Sheet 1 of 3)

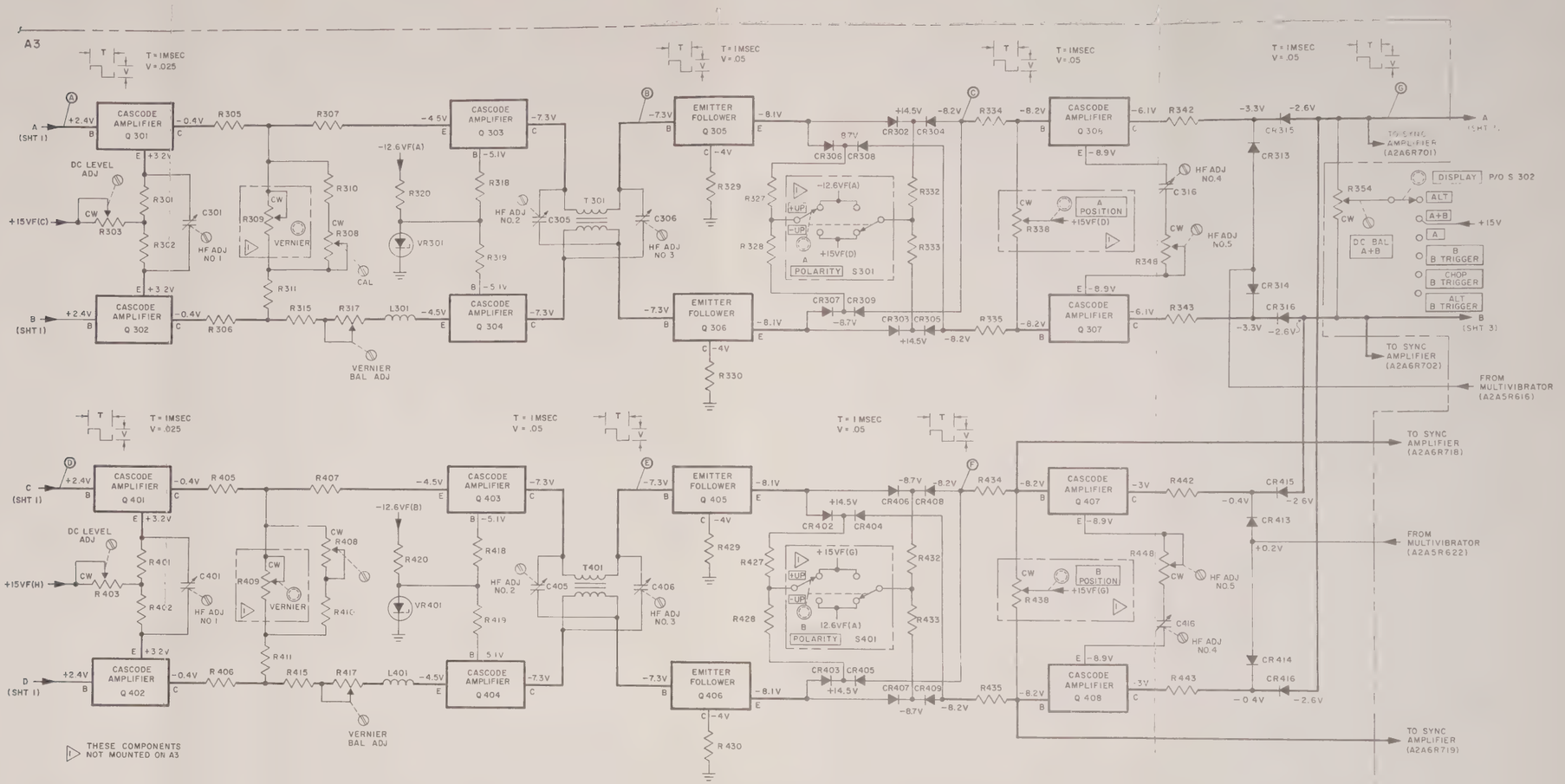


Figure 4-9. Dual Channel Vertical Amplifiers and Attenuators Functional and Servicing Block Diagram (Sheet 2 of 3)

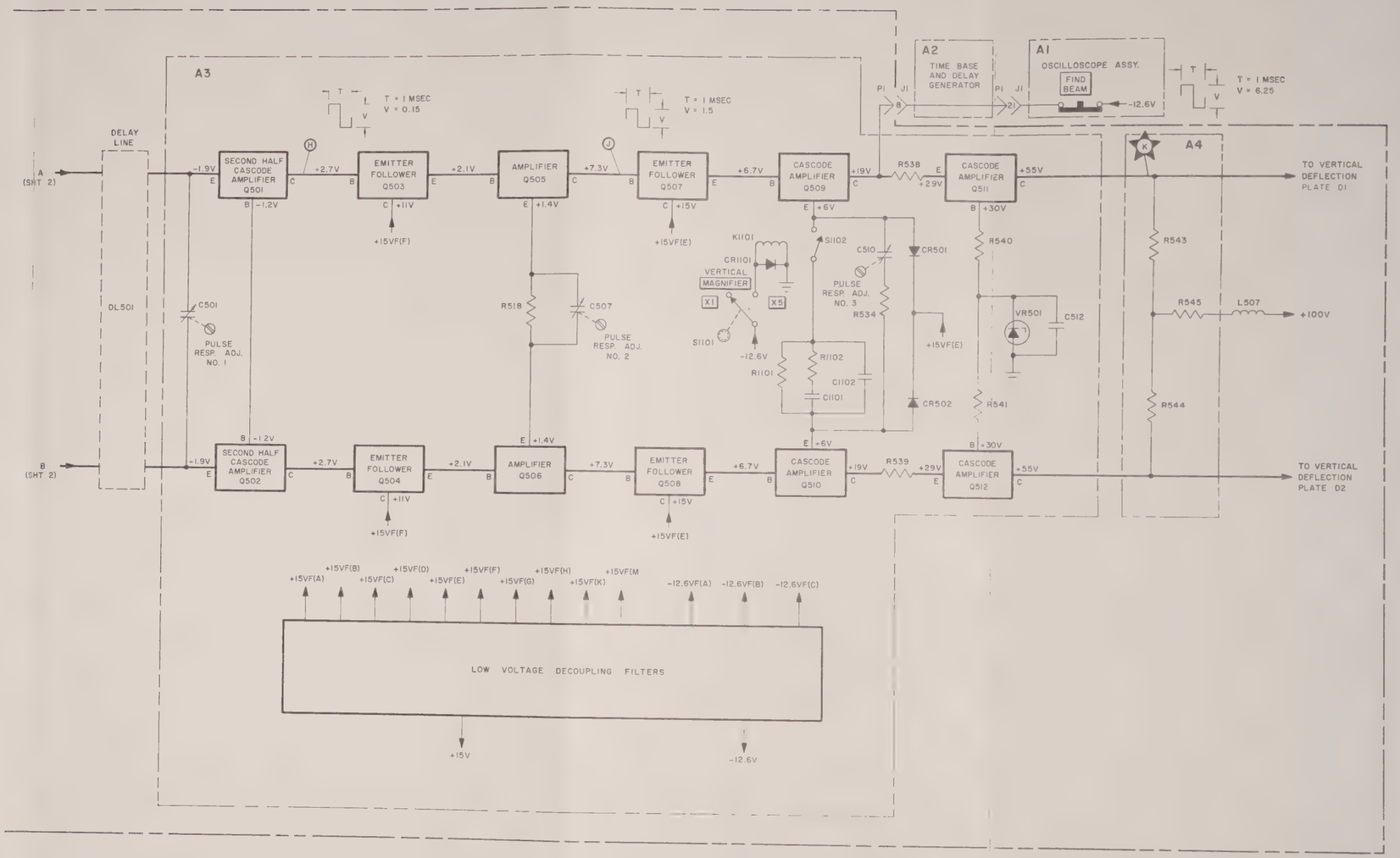


Figure 4-9. Dual Channel Vertical Amplifiers and Attenuators Functional and Servicing Block Diagram (Sheet 3 of 3)

4-12. MULTIVIBRATOR.

a. MULTIVIBRATOR FUNCTIONAL DESCRIPTION. - The multivibrator (consisting of A2A5Q601 and A2A5Q602) is controlled by vertical DISPLAY switch A2S302. See figure 4-10. In the A and B positions the multivibrator is monostable and does not switch. In ALT and ALT B TRIGGER the multivibrator is bistable, in CHOP B TRIGGER the multivibrator is free-running and in A+B the multivibrator is inoperative.

Setting vertical DISPLAY switch A2S302 to position A biases A2A4Q602 on, causing A2A5Q601 to turn off. The negative output at the collector of A2A5Q601 is coupled through A2A5Q603 to the channel A gate circuit and allows the channel A signal to pass through the gate. (Refer to paragraph 4-11a.) The positive output at the collector of A2A5Q602 is coupled through A2A5Q604 to the channel B gate circuit and blocks the channel B signal. Setting the vertical DISPLAY switch to B turns A2A5Q601 on and A2A5Q602 off to display the channel B signal and block the channel A signal.

Setting the vertical DISPLAY switch to ALT or ALT B TRIGGER applies +15 vdc to A2A5R607 and A2A5R610 to bias the multivibrator for bistable operation. A negative trigger signal from the gate amplifier in the oscilloscope assembly (refer to paragraph 4-8a) is applied through diodes A2A5CR603 and A2A5CR604 to the base of A2A5Q601 and A2A5Q602. The negative trigger signal is generated at the completion of each sweep and causes the multivibrator to change state. This causes each channel to alternately turn on and off at the completion of the horizontal sweep.

When the vertical DISPLAY switch is set to CHOP B TRIGGER, a 12.6 vdc is applied to A2A5R607 and A2A5R610. This biases the multivibrator for astable operation and the multivibrator free-runs at a 400 kHz rate. The -12.6 vdc also biases diodes A2A5CR603 and A2A5CR604 off to prevent the trigger pulses from the gate amplifier in the oscilloscope assembly from affecting the multivibrator. In this mode of operation, resistor A2A5R627 is grounded and the reverse bias is removed from diodes A2A5CR608 and A2A5CR609. The positive output pulses generated by A2A5Q603 and A2A5Q604 pass through the diodes and are applied to chopped blanking amplifier A2A5Q605 and A2A5Q606. Transistors A2A5Q605 and A2A5Q606 amplify and clip the input pulses and apply positive blanking pulses to the gate amplifier in the oscilloscope assembly. (Refer to paragraph 4-8a.) These positive blanking pulses cause the gate amplifier to cut off the CRT when the multivibrator switches to prevent switching transients from appearing in the trace.

If the vertical DISPLAY switch is set to A+B, all bias voltages are removed from the multivibrator and the multivibrator is cut off. A negative bias is applied to A2A5Q603 and A2A5Q604 causing these transistors to turn off. A negative voltage is applied to each gate and both the channel A and B gates are turned on. The input signals to both channels then pass through the gate circuit and their combined output is displayed.

b. MULTIVIBRATOR TROUBLE SHOOTING. - The trouble-shooting chart for the multivibrator functional section is provided in table 4-9 and the servicing block diagram is shown in figure 4-10.

The multivibrator functional section controls the gate to the vertical output amplifier and, acting as an on/off switch, determines which input signal (A and/or B) is applied to the vertical output amplifier. A malfunction in this section could cause any of the following problems: A failure of the oscilloscope to operate in any of the dual trace modes, a failure of the oscilloscope to operate in the A or B mode, an incorrect display while operating in the A or B mode, and the appearance of switching transients when operating in the CHOP B TRIGGER mode. If the oscilloscope does not produce a dual trace in the ALT, ALT B TRIGGER, or CHOP B TRIGGER modes but operates in the A+B mode, the multivibrator is at fault. If the oscilloscope operates in the CHOP B TRIGGER mode and not in the alternate modes, check the multivibrator triggering circuit and the gate amplifier functional section. If the vertical amplifier functions on one channel and does not function on the other channel or in the A+B mode, or if an incorrect display is produced while operating in a single channel mode, check for shorted or open transistors A2A5Q603 and A2A5Q604 (figure 4-10) or defective multivibrator (A2A5Q601/A2A5Q602). If switching transients appear while operating in the CHOP B TRIGGER mode and the trace appears to be of normal intensity, check the chopped blanking amplifier (A2A5Q605/A2A5Q606) in this functional section.

When the malfunction has been isolated to the multivibrator functional section, perform the procedures in table 4-9 to isolate the defective component.

c. USEFUL ILLUSTRATIONS. - Illustrations useful in maintaining this functional section are: Figures 4-10, 5-24 and 5-31.

TABLE 4-9. MULTIVIBRATOR TROUBLE SHOOTING

STEP	ACTION	RESULTS	NEXT STEP
1	Set oscilloscope control as follows: Set POLARITY (A and B) to +UP. Set VOLTS/CM (A and B) to 1.	Waveform is correct.	2
		If waveform is incorrect, check A2A5Q601, A2A5Q602, A2A5CR601 through A2A5CR604 and DISPLAY	

TABLE 4-9. (Continued)

STEP	ACTION	RESULT	NEXT STEP
1 (Cont)	Set vernier VOLTS/CM (A and B) to CAL. Set input coupling (A and B) to GND. Set vertical DISPLAY to CHOP B TRIGGER. Set time base and delay generator to produce main sweep. Observe waveform at test point A and compare with that shown in figure 4-10. NOTE To obtain voltages shown in figure 4-10, the vertical DISPLAY must be set to A.	switch A2S302. Also check decoupling filter network.	
2	Observe waveform at test point C and compare with that shown in figure 4-10.	Waveform is correct.	3
		If waveform is incorrect, check A2A5Q603, A2A5Q604, A2A5CR608, A2A5CR609 and vertical DISPLAY switch A2S302.	
3	Observe waveform at test point D and compare with that shown in figure 4-10.	Waveform is correct.	4
		If waveform is incorrect, check A2A5Q605 and A2A5C612.	
4	Observe waveform at test point E and compare with that shown in figure 4-10.	If waveform is correct, the multivibrator functional section is operating properly. Check the dual channel vertical amplifiers and attenuators functional section and the gate amplifier functional section.	
		If waveform is incorrect, check A2A5Q606.	

4-13. SYNC AMPLIFIER.

a. SYNC AMPLIFIER FUNCTIONAL DESCRIPTION. - The composite vertical signal from the gate circuit (refer to paragraph 4-11a) is applied to the base of A2A3Q701 and A2A3Q702. See figure 4-11. The signal is amplified, inverted and applied through emitter followers A2A3Q703 and A2A3Q704 to a diode switch (A2A6CR701 through A2A6CR704). Composite inverter current control A2A3R707 adjusts the operating point of the inverter-amplifier. The signal from the channel B amplifier (refer to paragraph 4-11a) is applied through emitter followers A2A6Q705 and A2A6Q706 to a diode switch consisting of A2A5-CR705 through A2A6CR708. Vertical DISPLAY switch A2S302 controls the two diode switches and determines which one is on and which one is off. In the ALT, A+B, A and B modes, diodes A2A6CR701 through A2A6CR704 are on and the composite vertical signal is applied to cascode amplifier A2A6Q707 through A2A6Q710. Diodes A2A6CR705 through A2A6CR708 are off and the channel B signal is blocked. In the CHOP B TRIGGER and ALT B TRIGGER modes, diodes A2A6CR705 through A2A6CR708 are on and the channel B signal is applied to the cascode amplifier. The composite vertical signal is blocked. A2A6R715 balances the dc output when the composite signal is selected and A2A6R729 balances the output when the channel B signal is selected. The output of the cascode amplifier is applied to balun amplifier

NOTES:

1. Primary signal paths weighted.

2. Waveforms recorded with an AN/USM-281 oscilloscope.
   Control settings: .05V/CM, .2V/CM, 1V/CM, 2V/CM
   Sweep time: .5US/CM

3. Explanation of symbols placed at waveforms:
   T = Duration of the portion of waveform indicated
   V = Peak-to-peak voltage

4. Operating control settings for dc voltage measurement conditions:
   Vertical DISPLAY to A
   POLARITY (both channels) to +UP
   VOLTS/CM (both channels) to 1
   Vernier VOLTS/CM (both channels) to CAL
   Input coupling (both channels) to GND
   A POSITION to center trace

5. Operating control settings for waveform measurement conditions:
   Vertical DISPLAY to CHOP

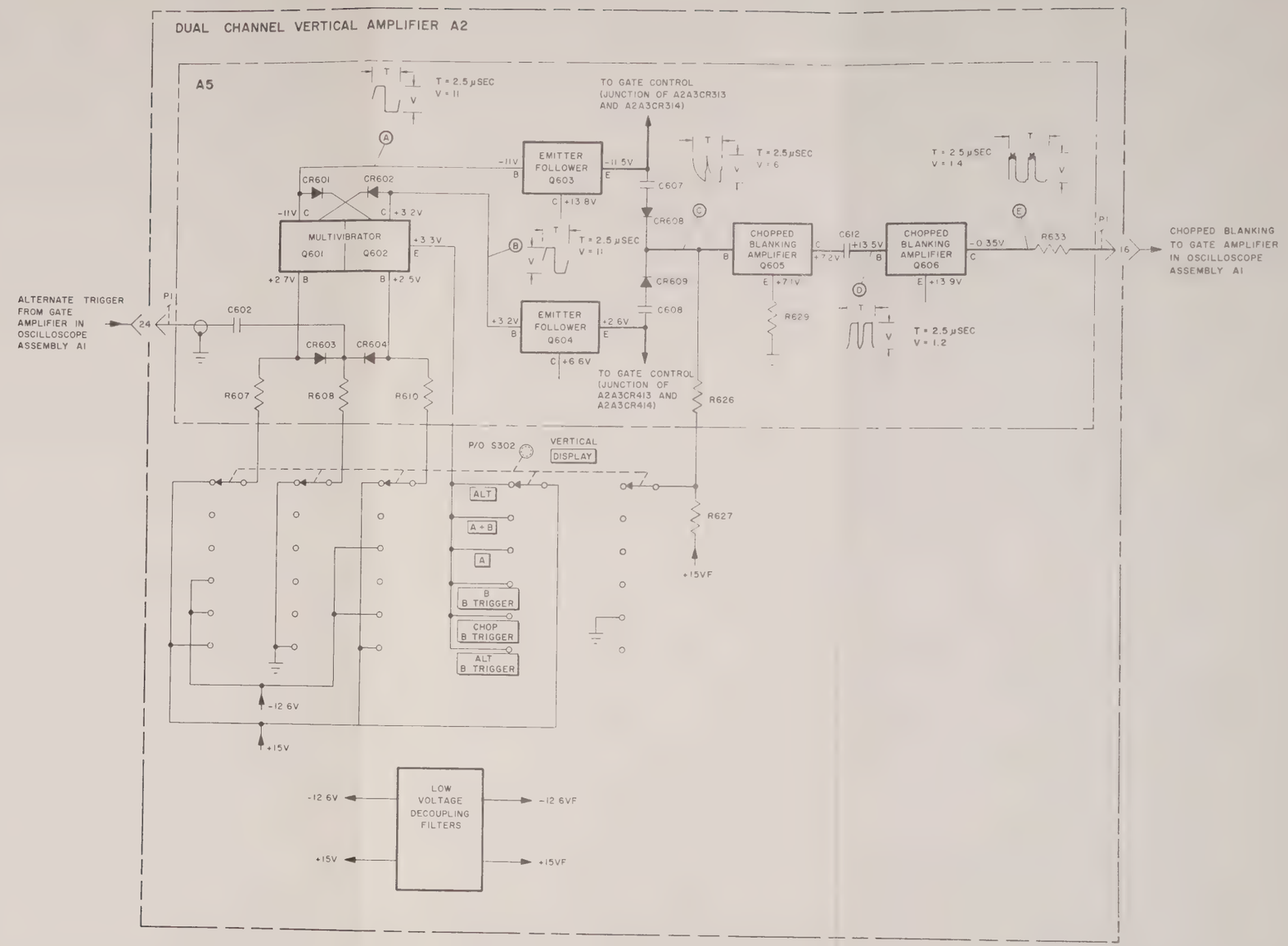


Figure 4-10. Multivibrator Functional and Servicing Block Diagram

A2A6Q711 through A2A6Q713. The balun amplifier converts the balanced push-pull signal into a single-ended signal. A2A6R751 sets the operating point of the balun amplifier. The single-ended output of the balun amplifier is amplified by A2A6Q714 and is coupled through complementary emitter follower A2A6Q715/A2A6Q716 to the internal trigger amplifier in the time base and delay generator. (Refer to paragraph 4-14a.) Diodes A2A6CR710 and A2A6CR711 prevent transistor A2A6Q714 from saturating. In the CHOP B TRIGGER mode of operation, diodes A2A6-CR712 and A2A6CR713 are forward biased causing capacitor A2A6C719 to appear in the base circuit of the complemenatry amplifier which decreases the bandwidth of the trigger amplifier. This prevents the sweep from being triggered by high frequency noise.

b. SYNC AMPLIFIER TROUBLE SHOOTING. - The trouble-shooting chart for the sync amplifier functional section is provided in table 4-10 and the servicing block diagram is shown in figure 4-11. A trouble can usually be isolated to this functional section by setting the oscilloscope controls to obtain a main sweep (refer to Section 3), connecting the CALIBRATOR 250MV output to one of the vertical inputs and observing the CRT. With the main trigger coupling set to INT and the SWEEP MODE in AUTO, a stable display should appear on the CRT. If the display can not be stabilized by adjusting the main TRIGGER LEVEL, set the SWEEP MODE to NORM and observe the display. If the display remains on the CRT (stable or unstable), the trouble is probably in the main trigger generator and amplifier functional section. If the display disappears, the trouble is probably in the sync amplifier. Further isolate the malfunction by connecting the CALIBRATOR 10V output to the main EXT INPUT and setting the main trigger source to EXT ÷ 10. If a stable trace appears, the trouble is in the sync amplifier or in the internal trigger amplifier (A3A2Q101/A3A2Q102) in the time base and delay generator (figure 4-12). If a display can not be obtained by adjusting the main TRIGGER LEVEL, the trouble is in the main trigger generator and amplifier functional section.

When the trouble has been isolated to the sync amplifier functional section, perform the procedures in table 4-10 to isolate the defective component. After completing the repair, refer to Section 5 and perform the B trigger balance, trigger output level, composite trigger balance, and composite trigger balance adjustments.

c. USEFUL ILLUSTRATIONS. - Illustrations useful in maintaing this functional section are: Figures 4-11, 5-22, 5-25 and 5-31.

TABLE 4-10. SYNC AMPLIFIER TROUBLE SHOOTING

STEP	ACTION	RESULTS	NEXT STEP
1	Set oscilloscope controls as follows: Set vertical DISPLAY to A. Set POLARITY (A and B) to +UP. Set VOLTS/CM (A and B) to 2. Set vernier VOLTS/CM (A and B) to CAL. Set INPUT coupling to AC. Connect the CALIBRATOR 10V output through a tee-connector to the channel A and B INPUT. Observe waveform at test point A and compare with that shown in figure 4-11. NOTE To obtain voltages shown in figure 4-11, the channel A and B input coupling must be set to GND.	Waveform is correct.	2
		If waveform is incorrect, check dual channel vertical amplifiers and attenuators functional section.	
2	Observe waveform at test point B and compare with that shown in figure 4-11.	Waveform is correct.	3
		If waveform is incorrect, check A2A3Q701 and A2A3Q702.	

TABLE 4-10. (Continued)

STEP	ACTION	RESULTS	NEXT STEP
3	Observe waveform at test point D and compare with that shown in figure 4-11.	Waveform is correct.	4
		If waveform is incorrect, check A2A3Q703, A2A3Q704, A2A3CR701 through A2A3CR704 and vertical DISPLAY switch A2S302.	
4	Set vertical DISPLAY to ALT B TRIGGER. Observe waveform at test point D and compare with that shown in figure 4-11.	Waveform is correct.	5
		If waveform is incorrect, check A2A6Q705, A2A6Q706, A2A6CR705 through A2A6CR708 and low voltage decoupling filter. If these components are not defective, check the dual channel vertical amplifiers and attenuators functional section.	
5	Set vertical DISPLAY to A. Observe waveform at test point E and compare with that shown in figure 4-11.	Waveform is correct.	6
		If waveform is incorrect, check A2A6Q707 through A2A6Q710.	
6	Observe waveform at test point F and compare with that shown in figure 4-11.	Waveform is correct.	7
		If waveform is incorrect, check A2A6Q711 through A2A6Q713 and A2A6VR702.	
7	Observe waveform at test point G and compare with that shown in figure 4-11.	Waveform is correct.	8
		If waveform is incorrect, check A2A6Q714, A2A6CR710, A2A6CR711 and A2A6VR701.	
8	Observe waveform at test point H and compare with that shown in figure 4-11.	If waveform is correct, check A2J2 and main trigger generator and amplifier functional section.	
		If waveform is incorrect, check A2A6Q715, A2A6Q716, A2A6CR712, A2A6CR713 and A2A6VR703. If A2A6Q715 or A2A6Q716 is defective, check A3A2Q101 and A3A2Q102 in the main trigger generator and amplifier functional section.	

4-14. MAIN TRIGGER GENERATOR AND AMPLIFIER.

a. MAIN TRIGGER GENERATOR AND AMPLIFIER FUNCTIONAL DESCRIPTION. - The trigger signal is selected by main trigger source switch A3S101 and applied through trigger coupling switch A3S102 to source follower A3A1Q103. When one of the external positions is selected, the external signal is applied through main EXT INPUT connector A3J101 directly to A3S102 in the EXT position, and through an X10 attenuator (A3R103/A3R104) in the EXT ÷10 position. When the LINE position is selected, a signal from the input power line is applied through attenuator A3A1R101/A3A1R102 to provide a 10 v peak-to-peak signal to the trigger coupling switch. When INT is selected, the internal trigger signal from the sync amplifier (refer to paragraph 4-13a) is amplified by A3A2Q101/A3A2Q102 and applied to the trigger coupling switch. Trigger coupling switch A3S102 selects DC (direct coupling), AC (capacitive coupling), ACS (low-pass filter coupling) or ACF (high-pass filter

NOTES:

1. Primary signal paths weighted.
2. Waveforms recorded with an AN/USM-281 oscilloscope.
   Control settings:
   Sensitivity: .05V/CM, .2V/CM, .5V/CM
   Sweep time: .2MS/CM
3. Explanation of symbols placed at waveforms:
   T = Duration of the portion of waveform indicated
   V = Peak-to-peak voltage
4. The letters cw placed adjacent to the appropriate terminals of a potentiometer indicate the maximum clockwise rotation.
5. Operating control settings for dc voltage measurement conditions:
   Vertical DISPLAY to A
   POLARITY (both channels) to +UP
   VOLTS/CM (both channels) to 1
   Vernier VOLTS/CM (both channels) to CAL
   Input coupling (both channels) to GND
   A POSITION to center trace
6. Operating control settings for waveform measurement conditions:
   Vertical DISPLAY to A
   POLARITY (both channels) to +UP
   VOLTS/CM (both channels) to 2
   Vernier VOLTS/CM (both channels) to CAL
   Input coupling (both channels) to AC
   A POSITION to center trace
   Connect CALIBRATOR 10V output to the channel A and B INPUT connectors.

(1) These components not mounted on A6

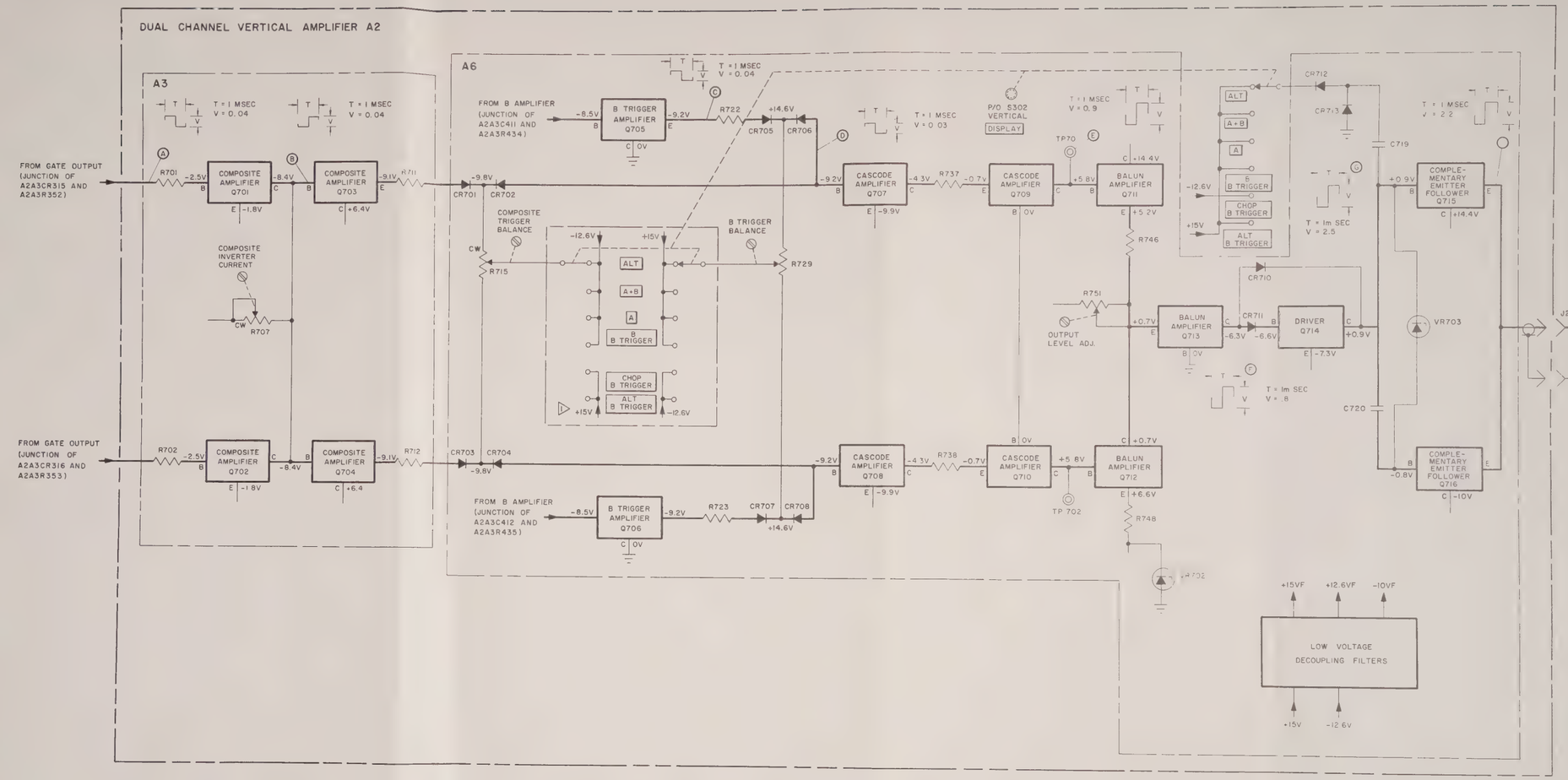


Figure 4-11. Sync Amplifier Functional and Servicing Block Diagram

coupling) and applies the trigger signal through the selected coupling to source follower A3A1Q103. Source follower A3A1Q103 presents a high impedance to the input signal and provides an amplified output to trigger comparator A2A1Q104/A3A1Q105. The comparator trigger level (base voltage on A3A1Q105) is established by level emitter follower A3A1Q106. The trigger level is adjustable by varying A3R121 and changing the current level through A3A1Q106. Main SLOPE switch A3S103 determines trigger slope by turning one of the comparator transistors on and the other off. If the + slope is selected, A3A1Q105 is turned on and the emitter current flow through A3A1R126 causes A3A1Q104 to be cut off. When the incoming trigger signal increases to a sufficient positive level (determined by main TRIGGER LEVEL), A3A1Q104 begins conducting and the current flow through A3A1CR106, A3A1CR107 and A3A1Q104 causes tunnel diode A3A1CR106 to switch and apply a negative-going rectangular trigger pulse to trigger generator A3A1Q107. If the - slope is selected, A3A1Q104 is turned on and the current flow through emitter resistor A3A1R126 biases A3A1Q105 off. A positive trigger signal on the base of A3A1Q104 maintains this condition and produces no trigger signal. As the incoming trigger signal goes negative, the current flow through A3A1Q104 and emitter resistor A3A1R126 decreases. When the emitter reaches the preset level (determined by main TRIGGER LEVEL), A3A1Q105 conducts. When A3A1Q105 conducts a current path is provided through A3A1CR106, A3A1CR108 and A3A1Q105. Tunnel diode A3A1CR106 switches and a negative-going trigger pulse is applied to A3A1Q107. The negative-going pulse is inverted by A3A1Q107, differentiated by A3A1C119 and A3A1R138, and applied to trigger amplifier A3A1Q108. The positive pulses are amplified and inverted by A3A1Q108 and a fast-rising negative pulse from the collector of A3A1Q108 is applied to the main sweep generator functional section and to the auto circuit.

In the NORM and SINGLE modes of operation, the -100 vdc is removed from the auto circuit. The monostable multivibrator is locked out and free-run lockout A3A1Q112 is turned on. The negative current flow through A3A1Q112 is applied to the base of free-run gate generator A3A1Q109 to turn A3A1Q109 off. The auto trigger signal produced by the main sweep generator is blocked by A3A1Q109 and has no effect. In the AUTO mode of operation, -100 vdc is applied to the auto circuitry to enable the monostable multivibrator and turn off A3A1Q112. If no trigger signal is applied, A3A1Q112 remains off allowing A3A1Q109 to function. The auto trigger signal from the main sweep generator is amplified by A3A1Q109, applied through A3A1R141 to trigger the main gate generator and the sweep is free-running. If a trigger signal is applied to the trigger generator, the negative pulses from A3A1Q108 are applied through A3A1CR116 to the monostable multivibrator (A3A1Q110/A3A1Q111). A3A1Q111 momentarily conducts discharging A3A1C123 and blocks diode A3A1CR117. A3A1Q112 conducts and causes A3A1Q109 to cut off and block the auto trigger. If the incoming trigger signal is above 40 Hz, A3A1C123 does not have sufficient time to charge between trigger pulses and free-run lockout A3A1Q112 remains on to block the auto trigger signal and provide a stable triggered display. If the incoming trigger signal is below 40 Hz, A3A1C123 charges fully between trigger signals causing A3A1Q112 to cut off which allows the sweep to be alternately triggered and free-run. This provides an unstable display.

b. MAIN TRIGGER GENERATOR AND AMPLIFIER TROUBLE SHOOTING. - The trouble-shooting chart for the main trigger generator and amplifier functional section is provided in table 4-11 and the servicing block diagram is shown in figure 4-12. A trouble in this functional section will usually cause an unstable main display or no display at all. To isolate a trouble to this functional section, connect the CALIBRATOR 250MV output to one of the vertical inputs and attempt to obtain a display (refer to Section 3). With the SWEEP MODE in AUTO, the main trigger source set to INT, and the main trigger coupling set to DC, a stable square wave should be displayed on the CRT. If the display can not be stabilized by adjusting the main TRIGGER LEVEL or if no display can be obtained, set the SWEEP MODE to NORM and observe the CRT. If the display was unstable in the AUTO mode and a stable display is obtained in the NORM mode, the trouble is probably in the monostable multivibrator (A3A1Q110/A3A1Q111) or the free-run lockout circuitry (A3A1Q112). See figure 4-12. If a display could not be obtained in the AUTO mode but a stable display is obtained in the NORM mode, the trouble is probably the free-run gate generator (A3A1Q109). If the display is still unstable or if a display cannot be obtained in the NORM mode; set the main trigger source to EXT ÷ 10, connect the CALIBRATOR 10V output to the main EXT INPUT and observe the CRT. If a stable trace is obtained, the problem is probably in the internal trigger amplifier (A3A2Q101/A3A2Q102) or the sync amplifier functional section. If the display is still unstable, the problem is probably in the main trigger generator and amplifier (A3A1Q103 through A3A1Q108). If a trace could not be obtained in either the AUTO or NORM modes, the problem could also be in the main sweep generator functional section.

When the manipulation of front-panel controls has isolated this functional section as the probable cause of the trouble, perform the procedures in table 4-11 to isolate the defective component. After locating the defective component and completing the repair, perform the trigger symmetry adjustment in Section 5.

c. USEFUL ILLUSTRATIONS. - Illustrations useful in maintaining this functional section are: Figures 4-12, 5-26, 5-27 and 5-32.

TABLE 4-11. MAIN TRIGGER GENERATOR AND AMPLIFIER TROUBLE SHOOTING

STEP	ACTION	RESULTS	NEXT STEP
1	Set oscilloscope controls as follows: Set horizontal DISPLAY to INT. Set SWEEP MODE to AUTO. Set main TRIGGER LEVEL to 0. Set main trigger source to EXT. Set main SLOPE to +. Set main trigger coupling to AC. Connect CALIBRATOR 10V output to main EXT INPUT. Observe waveform at test point A and compare with that shown in figure 4-12. NOTE To obtain voltages shown in figure 4-12, rotate main TRIGGER LEVEL fully cw, set main trigger source to EXT ÷ 10, set main trigger coupling to DC, and disconnect CALIBRATOR 10V output.	Waveform is correct	2
		If waveform is incorrect, check A3A1Q103, A3A1CR103 and trigger coupling switch A3S102.	
2	Observe waveform at test point B (TP101) and compare with that shown in figure 4-12.	Waveform is correct.	3
		If waveform is incorrect, check A3A1Q104 through A3A1Q106, A3A1CR104 through A3A1CR110 and main SLOPE switch A3S103.	
3	Observe waveform at test point C and compare with that shown in figure 4-12.	Waveform is correct.	4
		If waveform in incorrect, check A3A1Q107 and A3A1CR106.	
4	Observe waveform at test point D and compare with that shown in figure 4-12.	If waveform is correct and display is unstable, check A3A1Q109 through A3A1Q112, A3A1CR114, A3A1CR116 and A3A1CR117.	
		If waveform is correct and display is stable in the external positions but unstable in INT, check A3A2Q101, A3A2Q102, A3A2VR100 and sync amplifier functional section.	
		If waveform is correct and no display is present on CRT, check main sweep generator functional section.	
		If waveform is incorrect, check A3A1Q108 and A3A1VR101.	

NOTES:

1. Primary signal paths weighted. Feedback lines weighted and dashed.

2. Waveforms recorded with an AN/USM-281 oscilloscope.
   Control settings:
   Sensitivity: .05V/CM, 1V/CM, 2V/CM
   Sweep time: .2MS/CM

3. Explanation of symbols placed at waveforms:
   T = Duration of the portion of waveform indicated
   V = Peak-to-peak voltage

4. The letters cw placed adjacent to the appropriate terminals of a potentiometer indicate the maximum clockwise rotation.

5. Operating control settings for dc voltage measurement conditions:
   Horizontal DISPLAY to INT
   SWEEP MODE to AUTO
   Main TRIGGER LEVEL fully cw
   Main trigger source to EXT÷10
   Main SLOPE to +
   Main trigger coupling to DC

6. Operating control settings for waveform measurement conditions:
   Horizontal DISPLAY to INT
   SWEEP MODE to AUTO
   Main TRIGGER LEVEL to 0
   Main trigger source to EXT
   Main SLOPE to +
   Main trigger coupling to AC
   Connect the CALIBRATOR 10V output to the main EXT INPUT.

△1 These components not mounted on A1.

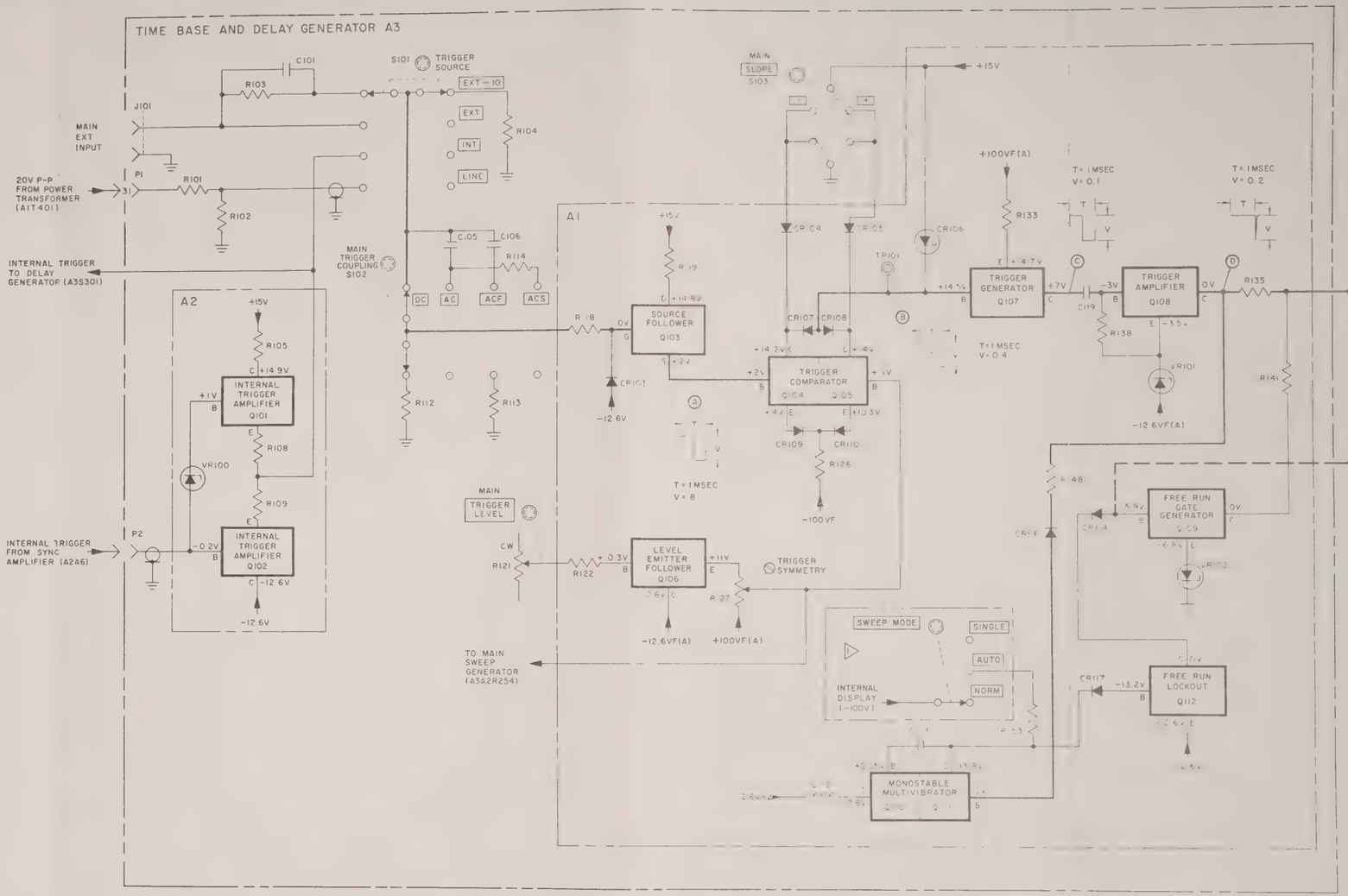


Figure 4-12. Main Trigger Generator and Amplifier Functional and Servicing Block Diagram

4-15. MAIN SWEEP GENERATOR.

a. MAIN SWEEP GENERATOR FUNCTIONAL DESCRIPTION. - When the main sweep generator receives a negative-going trigger pulse from the main trigger generator and amplifier functional section, tunnel diode A3A1CR201 switches and produces a negative signal. When the trigger pulse ends, the current from A3A1Q204 causes tunnel diode A3A1-CR201 to remain in this state. The negative signal produced by A3A1CR201 is amplified and inverted twice by A3A1Q201 and A3A1Q202 to produce a negative gate signal at the collector of A3A1Q202. Diodes A3A1CR202 through A3A1CR204 prevent A3A1Q201 from saturating. The negative gate signal is coupled through A3P1 pin 14 to the main gate output amplifier in the oscilloscope assembly (refer to paragraph 4-10a), to sweep display switch A3S502 to provide an intensity control signal to the gate amplifier (refer to paragraph 4-8a), and to the integrator circuit causing diode A3A2-CR210 to conduct. When A3A2CR210 conducts, diode switches A3A2CR211/A3A2CR215 are blocked. The timing capacitor (A3C501 through A3C510, depending on setting of main TIME/CM) begins charging through the timing resitor (A3R501 through A3R510) to the negative voltage established by the variable arm of A3R235. A3S501 determines the charging time (sweep speed) by selecting various RC time constants, and by controlling the base voltage of A3A2Q206 which determines the charging voltage. A3R235 adjusts charging voltage between the calibrated steps of the main TIME/CM control. The negative-going sweep voltage is applied to the gate of source follower A3A2Q207. A3A2Q207 presents a high impedance to the sweep signal and provides an output through A3A2R238 to A3A2Q208. A3A2R238 is variable and determines the quiescent output level of the circuit. A3A2Q208 amplifies and inverts the signal to provide a positive-going sweep signal to A3A2Q209. Emitter follower A3A2Q209 provides a low impedance sweep output through A3P1 pin 11 to the main sweep output amplifier in the oscilloscope assembly (refer to paragraph 4-10a), to sweep display switch A3S502 to be applied to the horizontal amplifier during the MAIN and MIXED modes of operation, and to the sweep comparator in the delayed sweep generator functional section. The positive-going sweep signal is also fed back to the selected timing capacitor to provide a linear sweep and is applied to the Main Schmitt Trigger and the hold-off circuit. The adjustable sweep signal to the Schmitt Trigger is applied through A3A2CR216 to the base of A3A1Q205. When the base of A3A1Q205 reaches the limit of the Schmitt Trigger, A3A1Q205 turns on and A3A1Q204 switches off. The current supplied to tunnel diode A3A1CR201 is removed and A3A1CR201 switches to remove the negative gate and terminate the sweep. A3A2R251 controls the voltage level applied to the Schmitt Trigger and determines sweep length. When the main gate is removed, diode A3A2CR210 is blocked and the positive current flow through A3A2CR211 and A3A2-CR215 discharges the timing capacitor. With A3A2-Q204 cut off, the gate circuit (A3A1CR201) is disabled and incoming trigger pulses have no effect.

As the main sweep is generated, the positive -going sweep signal is applied to hold-off emitter followers A3A2Q210 and A3A2Q211. The positive-going output of A3A2Q210 is applied through A3A2CR218 and A3A2CR219 to discharge the selected hold-off capacitor (A3C514 through A3C520). When the sweep is terminated by the Schmitt Trigger, A3A2CR218 is turned off and the hold-off capacitor begins to charge negatively. When the capacitor reaches a certain negative level, A3A2CR217 conducts and connects the hold-off capacitor to the base of A3A1Q205 in the Schmitt Trigger. The hold-off capacitor continues to charge and when the base voltage reaches the cut -off level of the Schmitt Trigger, A3A1Q205 turns off, switching A3A1Q204 on. A3A1Q204 again supplies current to tunnel diode A3A1CR201 and resets it to the pretrigger condition. The next trigger pulse will then start a new sweep. When A3A1Q205 is switched off, a positive pulse is coupled from the collector of A3A2Q205 to the main trigger generator and amplifier functional section to provide a free-running sweep while operating in the AUTO mode. The time between the end of one sweep and the resetting of the Schmitt Trigger is called hold-off and a new sweep cannot start until this time has elapsed. Hold-off time is varied slightly as the main TRIGGER LEVEL is adjusted to provide a stable display of certain discrete high-frequency signals. When A3A1Q204 is on, A3A1-Q203 is also on causing RESET indicator A3DS101 to light and indicate that the main gate (A3A1CR201) is in the reset (pretrigger) condition. If the SINGLE mode of operation is selected, the output of the hold-off circuit is clamped to ground through A3A2CR220 and the Schmitt Trigger does not automatically reset. To switch the Schmitt Trigger and reset the gate, the RESET pushbutton-indicator must be pressed. Pressing the RESET pushbutton-indicator applies a negative reset signal to A3A1Q205 and resets A3A1CR201. The next trigger pulse will then cause the sweep cycle to repeat.

b. MAIN SWEEP GENERATOR TROUBLE SHOOTING. - The trouble-shooting chart for the main sweep generator functional section is provided in table 4-12 and the servicing block diagram is shown in figure 4-13.

The main sweep generator functional section contains the main gate generator and the main sweep generator. A malfunction in this section can cause any of the following conditions: A failure to produce a trace or spot, a non-linear sweep, or a sweep of improper length. If a trace cannot be obtained and the screen is dark, check the gate amplifier functional section and the main trigger generator and amplifier functional section first. If these sections are functioning properly, the problem is probably in the main gate generator circuitry (A3A1Q201/A3A1Q202). See figure 4-13. If a spot or improper sweep is obtained while operating in the internal position, the problem is in the horizontal amplifier functional section or the main sweep generator functional section. The horizontal amplifier functional section can be quickly eliminated by setting the horizontal DISPLAY to EXT CAL, connecting the CALIBRATOR 10V output to the horizontal EXT INPUT and verifying that a trace of approximately 10 cm appears on the CRT. If the horizontal amplifier functional section is operating properly, return the horizontal DISPLAY to INT and set the SWEEP MODE to SINGLE. If a proper sweep can be obtained in the SINGLE mode, the trouble is probably in the hold-off emitter follower circuitry

(A3A2Q210/A3A2Q211). If the RESET pushbutton indicator does not light when pressed, the problem is probably in the Schmitt Trigger circuit (A3A1Q204/A3A1Q205). If a non-linear sweep is produced, the problem is in the integrator circuitry (A3A2Q206 through A3A2Q208).

When the malfunction has been isolated to the main sweep generator functional section, perform the procedures in table 4-12 to isolate the defective component. While trouble-shooting this functional section, keep in mind that the feedback and interaction between the circuits in this section can cause misleading indications. If the tracing waveforms (per table 4-12) fails to locate the defective component, set the controls as listed in figure 4-13 and check all voltages in this section. When an incorrect voltage is discovered, an analysis of the factors that could cause the improper voltage should aid in locating the defective component. After locating the defective component and completing the repair, refer to Section 5 and perform the main output level, main sweep length, and main sweep time adjustments.

c. USEFUL ILLUSTRATIONS. - Illustrations useful in maintaining this functional section are: Figures 4-13, 5-26, 5-27, 5-28 and 5-32.

TABLE 4-12. MAIN SWEEP GENERATOR TROUBLE SHOOTING

STEP	ACTION	RESULTS	NEXT STEP
1	Set oscilloscope controls as follows: Set horizontal DISPLAY to INT. Set MAIN VERNIER to CAL. Set sweep display to MAIN. Set main TIME/CM to 2 USEC. Set SWEEP MODE to AUTO. Observe waveform at test point A (TP201) and compare with that shown in figure 4-13. NOTE To obtain voltages shown in figure 4-13, test point A (TP201) must be grounded and the main TIME/CM must be set to 1 USEC.	Waveform is correct.	2
		If waveform is incorrect, check A3A1CR201 and main trigger generator and amplifier functional section.	
2	Observe waveform at test point B and compare with that shown in figure 4-13.	Waveform is correct.	4
		If waveform is incorrect, check A3A1Q201, A3A1Q202, A3A1CR202 through A3A1CR204, A3A2CR210 and A3A1C203.	3
3	Set main TIME/CM to 1 USEC and connect test point A to ground. Measure all dc voltages on A3A1Q204 and A3A1Q205 and compare with those shown in figure 4-13.	If voltage on base of A3A1Q205 is incorrect, check A3A1CR207.	4
		If voltage on base of A3A1Q205 is correct and the voltage on any other terminal is incorrect, check A3A1Q204, A3A1Q205, A3A1CR205 and A3A1CR206.	

TABLE 4-12. (Continued)

STEP	ACTION	RESULTS	NEXT STEP
4	Disconnect test point A from ground and set main TIME/CM to 2 USEC. Observe waveform at test point C and compare with that shown in figure 4-13.	Waveform is correct.	5
		If waveform is incorrect, check A3A2Q206, A3A2CR210, A3A2CR211, A3A2CR215 and main TIME/CM switch A3S501.	
5	Observe waveform at test point E (TP205) and compare with that shown in figure 4-13.	Waveform is correct.	6
		If waveform is incorrect, check A3A2Q207 through A3A2Q209, A3A2CR212 through A3A2CR214 and A3A2VR201.	
6	Observe waveform at test point G and compare with that shown in figure 4-13.	If waveform is correct, check auto circuitry (A3A2Q109 through A3A1Q112) in main trigger generator and amplifier functional section.	
		Waveform is incorrect.	7
7	Observe waveform at test point H and compare with that shown in figure 4-13.	If waveform is correct, check A3A2CR216, A3A2CR217, A3A2CR220 and SWEEP MODE switch A3S104.	
		If waveform is incorrect, check A3A2Q210, A3A2Q211 and A3A2CR218 through A3A2CR220.	

4-16. DELAYED TRIGGER GENERATOR AND AMPLIFIER.

a. DELAYED TRIGGER GENERATOR AND AMPLIFIER FUNCTIONAL DESCRIPTION. - The trigger signal is selected by delayed trigger source switch A3S301 and applied through delayed trigger coupling switch A3S302 to source follower A3A1Q301. When the INT, EXT, or EXT ÷10 trigger mode is selected, the delayed trigger generator and amplifier functions the same as the main trigger generator and amplifier with the exception that there is no auto circuitry in the delayed trigger. (Refer to paragraph 4-14a.) When the delayed trigger source is set to AUTO, the trigger generator circuitry (A3A1Q301 through A3A1Q105) does not function. The positive-going auto trigger signal produced by the delayed sweep generator functional section is applied through A3A1CR309 to the base of trigger amplifier A3A1Q306. Trigger amplifier A3A1Q306 amplifies and inverts the auto trigger pulse to provide a sharp negative-going trigger signal to the delayed sweep generator functional section. When trigger source switch A3S301 is in any position except AUTO, a -100 vdc is applied through A3A1R328 to cut diode A3A1CR309 off and block the auto trigger signal from the delayed sweep generator.

The delayed SLOPE switch A3S303 and the delayed TRIGGER LEVEL A3R313 have the same function as their corresponding controls in the main trigger generator and amplifier.

b. DELAYED TRIGGER GENERATOR AND AMPLIFIER TROUBLE SHOOTING. - The trouble-shooting chart for the delayed trigger generator and amplifier functional section is provided in table 4-13 and the servicing block diagram is shown in figure 4-14.

A trouble in this functional section will usually result in the inability to obtain a delayed sweep, or an unstable delayed sweep. Prior to trouble shooting this functional section, insure that the main sweep is functioning properly because the main sweep (in conjunction with the CM DELAY) controls the delayed sweep. If a delayed sweep cannot be obtained in the MIXED or DELAYED modes but an intensified trace can be obtained in the MAIN mode, the problem is probably in the sweep display switch. If a delayed sweep can be obtained in the AUTO trigger source position but can not be obtained in any of the other trigger source positions, the problem is in this functional section. If the main sweep is functioning properly but a delayed sweep and an intensified trace can not be obtained in any trigger source position, the trouble is in this functional section or the delayed sweep generator functional section.

When this functional section has been isolated as a possible source of the trouble, perform the pro-

NOTES:

1. Primary signal paths weighted lines. Feedback paths weighted and dashed.

2. Waveforms recorded with an AN/USM-281 oscilloscope.
   Control settings:
   Sensitivity: .1V/CM, .5V/CM, 1V/CM, 5V/CM
   Sweep time: 5US/CM

3. Explanation of symbols placed at waveforms:
   T = Duration of the portion of waveform indicated
   V = Peak-to-peak voltage

4. The letters cw placed adjacent to the appropriate terminals of a potentiometer indicate the maximum clockwise rotation.

5. Operating control settings for dc voltage measurement conditions:
   Horizontal DISPLAY to INT
   SWEEP MODE to AUTO
   MAIN VERNIER to CAL
   Sweep display to MAIN
   Main TIME/CM to 1 USEC
   TP201 connected to ground

6. Operating control settings for waveform measurement conditions:
   Horizontal DISPLAY to INT
   SWEEP MODE to AUTO
   MAIN VERNIER to CAL
   Sweep display to MAIN
   Main TIME/CM to 2 USEC

These components not mounted on A2.

Figure 4-13. Main Sweep Generator Functional and Servicing Block Diagram (Sheet 1 of 2)

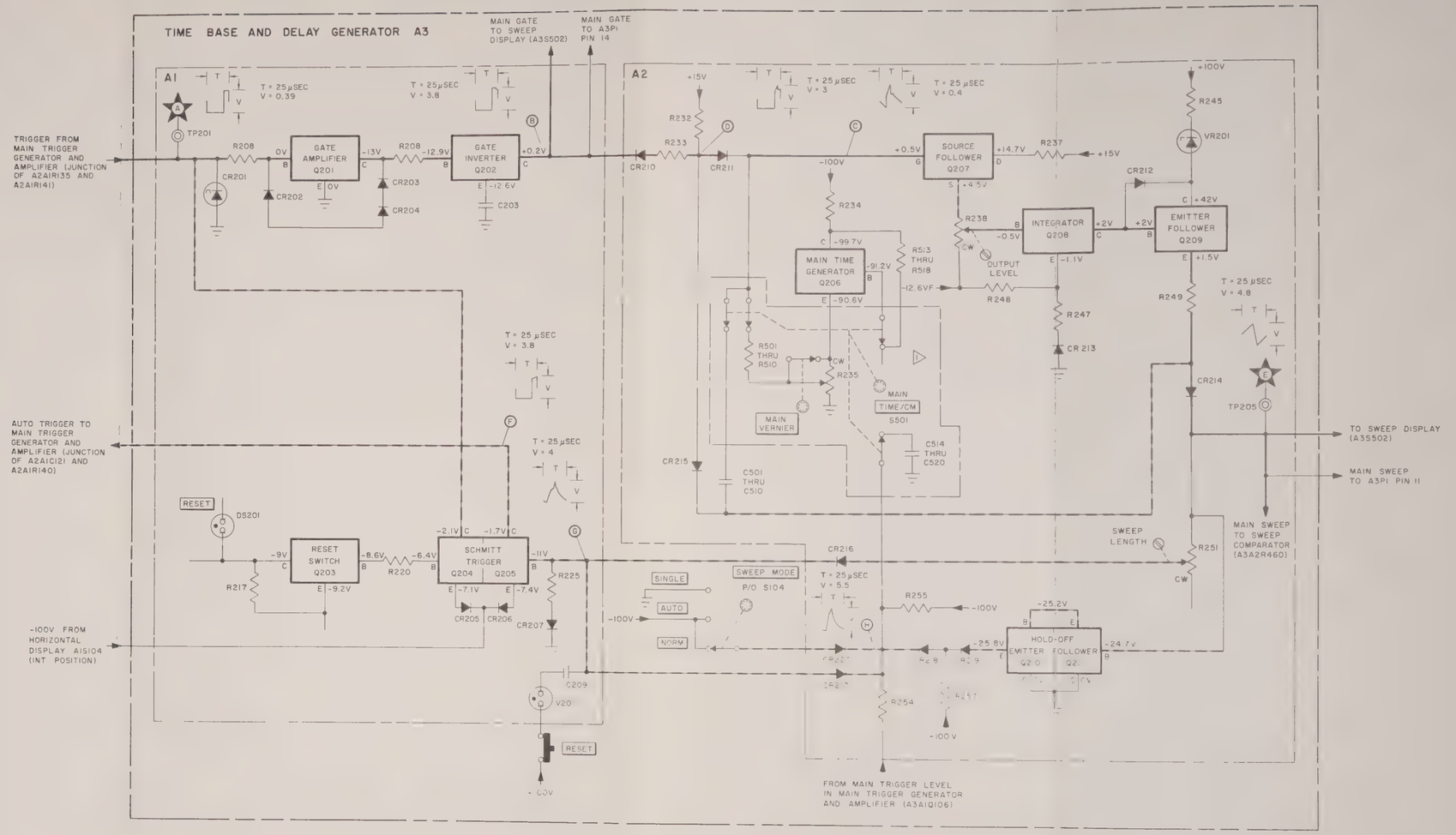


Figure 4-13. Main Sweep Generator Functional and Servicing Block Diagram (Sheet 2 of 2)

cedures in table 4-3 to locate the defective component or to eliminate this functional section. After replacing a component or making a repair to this functional section, perform the trigger symmetry adjustment in Section 5.

c. USEFUL ILLUSTRATIONS. - Illustrations useful in maintaining this functional section are: Figures 4-14, 5-26 and 5-32.

TABLE 4-13. DELAYED TRIGGER GENERATOR AND AMPLIFIER TROUBLE SHOOTING

STEP	ACTION	RESULTS	NEXT STEP
1	Set oscilloscope controls as follows: Set horizontal DISPLAY to INT. Set SWEEP MODE to AUTO. Set delayed TRIGGER LEVEL to 0. Set delayed trigger source to EXT. Set delayed SLOPE to +. Set delayed trigger coupling to AC. Connect CALIBRATOR 10V output to delayed EXT INPUT. Observe waveform at test point A and compare with that shown in figure 4-14. NOTE To obtain voltages shown in figure 4-14, the CALIBRATOR 10V output must be disconnected, the delayed TRIGGER LEVEL rotated fully cw, the delayed trigger source set to EXT ÷ 10 and the delayed trigger coupling set to DC.	Waveform is correct.	2
		If waveform is incorrect, check A3A2Q301, A3A2CR301 and A3S301. Also check low voltage decoupling filters.	
2	Observe waveform at test point B and compare with that shown in figure 4-14.	Waveform is correct.	3
		If waveform is incorrect, check A3A2Q302 through A3A2Q304 and A3A2CR302 through A3A2CR308.	
3	Observe waveform at test point C and compare with that shown in figure 4-14.	Waveform is correct.	4
		If waveform is incorrect, check A3A2Q305.	
4	Observe waveform at test point D and compare with that shown in figure 4-14.	If waveform is correct, check delayed sweep generator functional section.	
		If waveform is incorrect, check A3A2Q306, A3A2VR301, A3A2CR309 and A3S301.	

NOTES:

1. Primary signal paths weighted. Feedback paths weighted and dashed.

2. Waveforms recorded with an AN/USM-281 oscilloscope.
   Control settings:
   Sensitivity: .05V/CM, .1V/CM, 2V/CM
   Sweep time: .2MS/CM

3. Explanation of symbols placed at waveforms:
   T = Duration of the portion of waveform indicated
   V = Peak-to-peak voltage

4. The letters cw placed adjacent to the appropriate terminals of a potentiometer indicate the maximum clockwise rotation.

5. Operating control settings for dc voltage measurement conditions:
   Horizontal DISPLAY to INT
   SWEEP MODE to AUTO
   Delayed TRIGGER LEVER fully cw
   Delayed trigger source to EXT÷10
   Delayed SLOPE to +
   Delayed trigger coupling to DC

6. Operating control settings for waveform measurement conditions:
   Horizontal DISPLAY to INT
   SWEEP MODE to AUTO
   Delayed TRIGGER LEVEL to 0
   Delayed SLOPE to +
   Delayed trigger coupling to AC
   Connect the CALIBRATOR 10V output to main EXT INPUT.

These components not mounted on A2.

Voltages listed for Q301 are typical. Actual voltages vary with the characteristics of the FET.

Figure 4-14. Delayed Trigger Generator and Amplifier Functional and Servicing Block Diagram (Sheet 1 of 2)

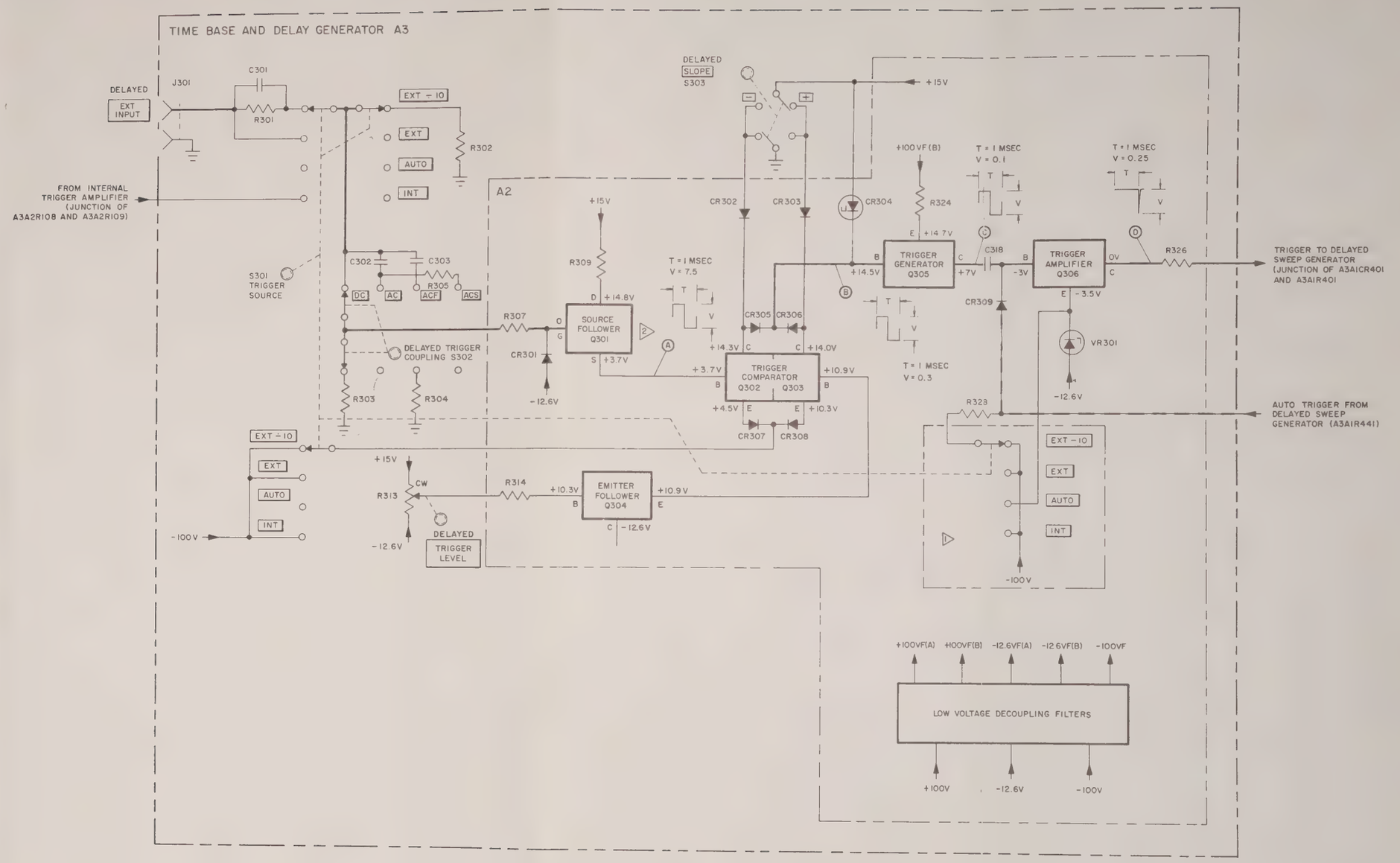


Figure 4-14. Delayed Trigger Generator and Amplifier Functional and Servicing Block Diagram (Sheet 2 of 2).

4-17. DELAYED SWEEP GENERATOR.

a. DELAYED SWEEP GENERATOR FUNCTIONAL DESCRIPTION. - When the delayed sweep generator receives a negative-going trigger pulse from the delayed trigger generator and amplifier functional section, tunnel diode A3A1CR401 switches and applies a negative rectangular pulse to A3A1Q401. The negative pulse is amplified and inverted twice by A3A1Q401 and A3A1Q402 to provide a negative gate signal at the collector of A3A1Q402. This negative gate signal is coupled through A3P1 pin 13 to the delayed gate output amplifier in the oscilloscope assembly (refer to paragraph 4-10a), to sweep display A3S502 to provide an intensity control signal to the gate amplifier, and to the delayed integrator circuit. The delayed integrator circuit (A3A2Q405 through A3A2Q408) functions the same as the main integrator circuit (refer to paragraph 4-15) to provide a positive-going delayed sweep at the emitter of A3A2Q408. The positive-going delayed sweep output is applied through A3P1 pin 12 to the delayed sweep output amplifier in the oscilloscope assembly, to sweep display switch A3S502 to be applied to the horizontal amplifier during the MIXED and DELAYED modes of operation, and through A3A2CR412 to A3A1Q404 in the delayed Schmitt Trigger. If the delayed sweep is completed before the main sweep ends (DELAYED mode) the positive voltage on the base of A3A1Q404 reaches the limit of the Schmitt Trigger and A3A1Q404 switches on, turning A3A1Q403 off to terminate the delayed sweep. A3A2R435 varies the voltage level to the Schmitt Trigger and determines delayed sweep length. When A3A1Q403 is off, the current to tunnel diode A3A1CR401 is reduced and A3A1CR401 cannot be triggered until the Schmitt Trigger is reset. If the main sweep ends before the delayed sweep is completed (mixed or delayed mode), the positive-going main sweep signal is removed from the base of A3A2Q411, and A3A2CR423 switches to apply a positive signal to the base of A3A2Q410. The negative-going output from the collector of A3A2Q410 is applied to the base of A3A1Q403 causing the Schmitt Trigger to switch and decrease the current to A3A1CR401 to terminate the sweep. This insures that the delayed sweep terminates before or at the same time as the main sweep to prevent the main sweep from restarting while the delayed sweep is still being generated.

The Schmitt Trigger reset signal is controlled by the sweep comparator (A3A2Q411/A3A2Q412). When the delayed TIME/CM is set to OFF, the -12.6 vdc is removed from the collector of A3A2Q413 and the sweep comparator is disabled. When the delayed TIME/CM is rotated from OFF, the -12.6 vdc is applied to the emitter of A3A2Q413 and transistor A3A2Q413 provides a constant current emitter source for the sweep comparator. The main sweep is coupled to the base of A3A2Q411 and is compared (in the emitter circuit) to the voltage level on the base of A3A2Q412. The voltage level on the base of A3A2Q412 is established by the setting of A3A2R471. When the main sweep voltage on the base of A3A2Q411 increases above the level established by CM DELAY A3A2R471, transistor A3A2Q411 begins conducting and causes tunnel diode A3A2CR423 to produce a sharp negative-going rectangular pulse. The negative-going pulse is amplified and inverted by A3A2Q410 and the positive-going output from the collector is applied through emitter-follower A3A2Q409 to the front-panel DELAYED TRIGGER OUTPUT, and to the base of A3A1Q403 in the Schmitt Trigger. The Schmitt Trigger resets and A3A1Q403 provides current to reset tunnel diode A3A1CR401 to the pretrigger condition. The next trigger pulse will then start the delayed sweep. The output from the sweep comparator is also applied through A3A1C413 to the delayed trigger generator and amplifier to provide an auto trigger signal. If the trigger source is in the AUTO mode, the delayed sweep starts immediately at the time the Schmitt Trigger is reset.

b. DELAYED SWEEP GENERATOR TROUBLE SHOOTING. - The trouble-shooting chart for the delayed sweep generator is provided in table 4-14 and the servicing block diagram is shown in figure 4-15.

A failure in this functional section can cause a loss of the delayed sweep, a non-linear delayed sweep, a delayed sweep of improper length and the inability to move the intensified trace smoothly along the main sweep. The main sweep must be operating properly to obtain a correct delayed sweep and should therefore be checked thoroughly for correct operation before suspecting the delayed sweep. If the main sweep is functioning properly and a delayed sweep cannot be obtained with the delayed trigger source in AUTO and the CM DELAY rotated clockwise from 0, the trouble is in this functional section or the delayed trigger generator and amplifier functional section. Check the delayed trigger generator and amplifier functional section (A3A2CR309 and A3A2Q306, figure 4-14) before checking this section. If a delayed sweep can be obtained but is non-linear, the problem is probably in the integrator circuitry (A3A2Q405 through A3A2Q408). See figure 4-15. If the delayed sweep is not of the proper length the problem is the Schmitt Trigger circuitry (A3A2Q403/A3A1Q404) or the delayed sweep output circuitry (A3A2Q407 and A3A2Q408). If an intensified trace can be obtained but can not be moved linearly across the main sweep (in the AUTO trigger source only), check the sweep comparator circuitry (A3A2Q410 through A3A2Q413).

When this functional section has been isolated as the probable cause of the trouble, perform the procedures in table 4-14 to locate the defective component. While trouble shooting this functional section, keep in mind that this section depends on feedback for its operation and therefore trouble shooting is more difficult. If tracing waveforms (per table 4-14) fails to locate the defective component, set the controls as listed in figure 4-15 and check all voltages in this section. When an incorrect voltage is discovered, an analysis of the factors that could cause the improper voltage should aid in locating the defective component. After locating the defective component and completing the repair, refer to Section 5 and perform the delayed output level, delayed sweep length, delayed sweep time and sweep comparator adjustments.

c. USEFUL ILLUSTRATIONS. - Illustrations useful in maintaining this functional section are: Figures 4-15, 5-26, 5-27, 5-28 and 5-32.

TABLE 4-14. DELAYED SWEEP GENERATOR TROUBLE SHOOTING

STEP	ACTION	RESULTS	NEXT STEP
1	Set oscilloscope controls as follows: Set horizontal display to INT. Set sweep display to MAIN. Set SWEEP MODE to AUTO. Set MAIN VERNIER to CAL. Set main TIME/CM to 2 USEC. Set DELAYED VERNIER to CAL. Set delayed TIME/CM to 1 USEC. Set delayed trigger source to AUTO. Set CM DELAY to 5.00. Observe waveform at test point F and compare with that shown in figure 4-15. NOTE To obtain voltages shown in figure 4-15, test point A (TP401) must be connected to a -12.6 vdc source through a 1k ohm resistor, the delayed TIME/CM must be set to .2 USEC and the CM DELAY must be set to 4.00.	Waveform is correct.	3
		If waveform is incorrect, check low voltage decoupling filters.	2
2	Observe waveform at test point G and compare with that shown in figure 4-15.	If waveform is correct, check A3A2Q410.	
		If waveform is incorrect, check A3A2Q411 through A3A2Q413, A3A2CR423 through A3A2CR425, A3A2VR401 and A3A2VR402.	
3	Connect a 1k ohm resistor from test point A (TP401) to -12.6 vdc supply and set SWEEP MODE to SINGLE. Measure all dc voltages on A3A1Q403 and A3A1Q404 and compare with those shown in figure 4-15.	Voltage on base of A3A1Q404 is correct.	4
		If voltage on base of A3A1Q404 is correct and the voltage on any other terminal is incorrect, check A3A1Q403, A3A1Q404, A3A1CR420 and A3A1CR421.	
4	Disconnect 1k ohm resistor from test point A and set SWEEP MODE to AUTO. Observe waveform at test point A (TP401) and compare with that shown in figure 4-15.	Waveform is correct.	5
		If waveform is incorrect, check A3A1CR401 and delayed trigger generator and amplifier functional section.	

TABLE 4-14. (Continued)

STEP	ACTION	RESULTS	NEXT STEP
5	Observe waveform at test point B and compare with that shown in figure 4-15.	Waveform is correct.	6
		If waveform is incorrect, check A3A1Q401, A3A1Q402, A3A1CR403 through A3A1CR406 and A3A2CR410.	8
6	Observe waveform at test point C and compare with that shown in figure 4-15.	Waveform is correct.	7
		If waveform is incorrect, check A3A2Q405, A3A2CR410, A3A2CR411 and A3A2CR413.	
7	Observe waveform at test point D (TP404) and compare with that shown in figure 4-15.	Waveform is correct.	8
		If waveform is incorrect, check A3A2Q406 through A3A2Q408, A3A2CR414 through A3A2CR416 and A3A2VR403.	
8	Observe waveform at test point E and compare with that shown in figure 4-15.	If waveform is correct, check A3A1Q403 and A3A1Q404.	
		If waveform is incorrect, check A3A2CR412 and A3A2R435.	

NOTES:

1. Primary signal paths weighted lines. Feedback paths weighted and dashed.

2. Waveforms recorded with an AN/USM-281 oscilloscope.
   Control settings:
   Sensitivity: .1V/CM, .5V/CM, 1V/CM, 2V/CM
   Sweep time: 5US/CM

3. Explanation of symbols placed at waveforms:
   T = Duration of the portion of waveform indicated
   V = Peak-to-peak voltage

4. The letters cw placed adjacent to the appropriate terminals of a potentiometer indicate the maximum clockwise rotation.

5. Operating control settings for dc voltage measurement conditions:
   Horizontal DISPLAY to INT
   Sweep display to MAIN
   Delayed TIME/CM to 2 USEC
   DELAYED VERNIER to CAL
   CM DELAY to 4.00
   TP401 connected to -12.6 vdc thru 1k ohm resistor

6. Operating control settings for waveform measurement conditions:
   Horizontal DISPLAY to INT
   Sweep display to MAIN
   SWEEP MODE to AUTO
   MAIN VERNIER to CAL
   Main TIME/CM to 2 USEC
   DELAYED VERNIER to CAL
   Delayed TIME/CM to 1 USEC
   Delayed trigger source to AUTO
   CM DELAY to 5.00

These components not mounted on A2

Figure 4-15. Delayed Sweep Generator Functional and Servicing Block Diagram (Sheet 1 of 2)

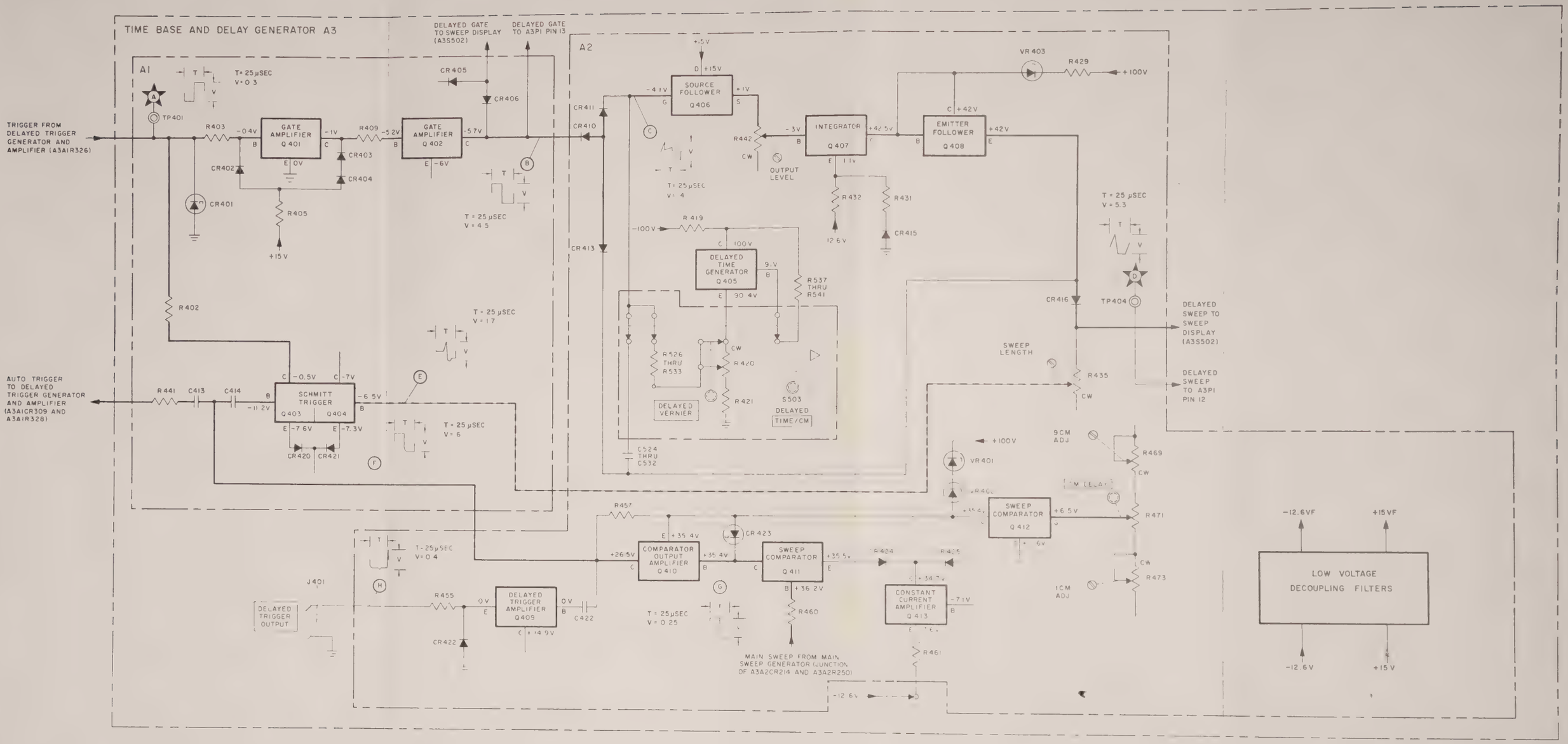


Figure 4-15. Delayed Sweep Generator Functional and Servicing Block Diagram (Sheet 2 of 2)

SECTION 5

MAINTENANCE

5-1. FAILURE, AND PERFORMANCE AND OPERATIONAL REPORTS.

NOTE

The Bureau of Ships no longer requires the submission of failure reports for all equipments. Failure Reports and Performance and Operational Reports are to be accomplished for designated equipment (refer to Electronics Installation and Maintenance Books, NAVSHIPS 900, 000) only to the extent required by existing directives. All failures shall be reported for those equipments requiring the use of Failure Reports.

5-2. PREVENTIVE MAINTENANCE.

Preventive maintenance consist of the periodic performance of the reference standards procedures to determine if the oscilloscope is functioning properly and the adjustment procedures required to maintain normal operation.

5-3. TEST EQUIPMENT AND ADAPTERS.

The test equipment and adapters required to perform the reference standards procedures and adjustment procedures is listed in table 5-1.

TABLE 5-1. TEST EQUIPMENT AND ADAPTERS REQUIRED FOR REFERENCE STANDARDS PROCEDURES AND ADJUSTMENT PROCEDURES

DESIGNATION	NAME
Model 738AR/BR	Voltmenter Calibrator (Hewlett-Packard)*
Model 140A with 1420A and 1402A	Oscilloscope with Plug-Ins (Hewlett-Packard)*
Model 10001A	10:1 Divider Probe (Hewlett-Packard)*
Type 191A	Constant Amplitude Signal Generator (Tektronix)*
Model 3440A with 3441A, and 3444A	Digital Voltmeter/Ammeter (Hewlett-Packard)*
ME-243/FQM	Electronic Volmeter
Model 11045A	100:1 Voltage Divider Probe (Hewlett-Packard)*
AN/USM-183	Multimeter
Resistor(s)-variable from 40k ohms to 400k ohms.	Variable Resistor (Commercial)
Model 211A	Square Wave Generator (Hewlett-Packard)*
0-1025/U	Oscillator (Audio-Radio Frequency)
Model 10100A	50-Ohm Termination (Hewlett-Packard)*
Model 8000A	Pulse Generator (Hewlett-Packard)*
Model 211B	Square Wave Generator (Hewlett-Packard)*
Type 130	LC Meter (Tektronix)*

TABLE 5-1. (Continued)

DESIGNATION	NAME
AN/URM-155	RF Millivoltmeter
Type 180	Time Mark Generator (Tektronix)*
Model 10407A	Plug-In Extender (Hewlett-Packard)*
UG-274 B/U	Tee-Connector (2 required)*
UG-273/U	Adapter, Male UHF to Female BNC*
UG-255/U	Adapter, Female UHF to Male BNC*
*Or equivalent	

5-4. REFERENCE STANDARDS PROCEDURES.

The reference standards procedures for the AN/USM-281 Oscilloscope are listed in table 5-2. If the oscilloscope does not meet the performance standards required by these procedures, perform the applicable adjustment procedure per paragraphs 5-5, 5-6 and 5-7. If the oscilloscope cannot be adjusted to meet the minimum performance standards, refer to Section 4 for oscilloscope trouble-shooting information.

NOTE

The procedures listed below constitute the minimum number of reference standards which will indicate, when completed, the relative performance of the oscilloscope and its plug-in units. The procedures are arranged in groups associated with the functional units of the oscilloscope. The oscilloscope assembly procedures must be performed first. Either of the remaining two units can be checked next. The performance check for each unit must be done in the order listed. Do not attempt to start the procedure in mid-sequence, as succeeding steps are dependent on control settings and results of previous steps.

TABLE 5-2. REFERENCE STANDARDS PROCEDURES

SECTION	ACTION REQUIRED	PROCEDURE STEPS
Oscilloscope Assembly (Table 5-3)	Check calibrator.	1 thru 7
	Check horizontal magnifier.	8 thru 12
	Check horizontal amplifier bandwidth.	13 thru 16
	Check beam finder.	17 thru 19
Dual Channel Vertical Amplifier (Table 5-4)	Check deflection factor.	1 thru 5
	Check vernier amplitude controls.	6 thru 9
	Check vertical magnifier.	10 thru 14

TABLE 5-2. (Continued)

SECTION	ACTION REQUIRED	PROCEDURE STEPS
Time Base and Delay Generator (Table 5-5)	Check common mode rejection.	15 thru 22
	Check vertical amplifier bandwidth.	23 thru 29
	Check triggering.	30 thru 39
	Check rise time.	40 thru 49
	Check triggering.	1 thru 13
	Check trigger point and slope.	14 thru 24
	Check main sweep time.	25 thru 27
	Check main sweep vernier.	28 thru 29
	Check delayed sweep time.	30 thru 31
	Check delayed sweep vernier.	32 thru 33
	Check delay time accuracy.	34 thru 43
	Check delay time linearily.	44 thru 50
	Check jitter.	51 thru 52
	Check delay trigger output.	53 thru 54
	Check mixed sweep.	55 thru 57
	Check single sweep.	58 thru 60

TABLE 5-3. OSCILLOSCOPE ASSEMBLY REFERENCE STANDARDS PROCEDURE

STEP NO.	ACTION REQUIRED	PERFORMANCE STANDARDS
	Preliminary Set-Up	Test Equipment Required
	Remove plug-in units and set POWER switch on. Set controls as follows: Set horizontal MAGNIFIER to X5. Set horizontal DISPLAY to EXT CAL. Set horizontal coupling to AC. Allow 15 minute warm-up period before proceeding.	Volmeter Calibrator, Model 738AR/BR Oscilloscope, Model 140A with 1420A and 1402A Constant Amplitude Signal Generator, Type 191A Adapter, Part No. UG-255/U
1	Connect a 10 v peak-to-peak signal from Voltmeter Calibrator output to horizontal EXT INPUT connector.	

TABLE 5-3. (Continued)

STEP NO.	ACTION REQUIRED	PERFORMANCE STANDARDS
2	Adjust INTENSITY and horizontal POSITION controls to obtain a centered trace.	
3	Adjust horizontal DISPLAY ccw to obtain exactly 10 cm of deflection.	
4	Disconnect Voltmeter Calibrator.	
5	Connect CALIBRATOR 10V output to horizontal EXT INPUT.	Trace 10 cm ± 1 mm
6	Disconnect CALIBRATOR 10V output from horizontal EXT INPUT.	
7	Observe CALIBRATOR 10V output with Test Oscilloscope.	Rise time less than 3 usec.
8	Set horizontal MAGNIFIER to X1 and horzontal DISPLAY to EXT CAL.	
9	Connect a 10 v peak-to peak signal from Voltmeter Calibrator output to horizontal EXT INPUT.	Trace 10 cm ± 3 mm
10	Adjust Voltmeter Calibrator output to 2 v peak-to-peak and set horizontal MAGNIFIER to X5.	Trace 10 cm ± 5 mm
11	Adjust Voltmeter Calibrator output to 1 v peak-to-peak and set horizontal MAGNIFIER to X10.	Trace 10 cm ± 5 mm
12	Disconnect Voltmeter Calibrator.	
13	Connect a 50 kHz signal from Constant Amplitude Signal Generator to Horizontal EXT INPUT.	
14	Set horizontal MAGNIFIER to X1 and adjust Signal Generator amplitude to produce 10 cm of deflection.	
15	Increase Signal Generator frequency to 5 MHz.	Trace deflection greater than 7.1 cm.
16	Disconnect Signal Generator.	
17	Rotate INTENSITY and HORIZONTAL POSITION controls fully ccw.	
18	Press FIND BEAM pushbutton.	Intensified beam
19	Readjust INTENSITY and HORIZONTAL POSITION.	

TABLE 5-4. DUAL CHANNEL VERTICAL AMPLIFIER REFERENCE STANDARDS PROCEDURE

STEP NO.	ACTION REQUIRED	PERFORMANCE STANDARDS
	Preliminary Set-Up	**Test Equipment Required**
	Lock plug-ins together and install in oscilloscope assembly. Set POWER switch on. After 15 minute warm-up period, perform turn-on and vertical amplifier adjustment procedures listed in table 3-3. Set oscilloscope controls as follows: Set horizontal MAGNIFIER to X1. Set horizontal DISPLAY to INT. Set vertical DISPLAY to A. Set A and B POLARITY to +UP. Set A and B vernier VOLTS/CM to CAL. Set A and B VOLTS/CM to 20. Set A and B coupling to AC. Set vertical MAGNIFIER to X1. Set sweep display to MAIN. Set SWEEP MODE to AUTO. Set MAIN VERNIER to CAL. Set main trigger source to INT. Set main SLOPE to +. Set main trigger coupling to AC. Set main TIME/CM to 1 MSEC Set delayed TIME/CM to OFF.	Voltmeter Calibrator, Model 738AR/BR Constant Amplitude Signal Generator, Type 191A Oscillator, 0-1025/U Pulse Generator, Model 8000A RF Millivoltmeter, AN/URM-155 50-Ohm Termination, Model 10100A Tee-Connector, UG-274 B/U Adapter, UG-255/U
1	Connect a 400 Hz signal from Voltmeter Calibrator output to channel A INPUT connector. Center trace with A POSITION.	
2	Set Voltmeter Calibrator output and channel A VOLTS/CM as listed below, and adjust main TRIGGER LEVEL as required for stable display. At each setting vertical deflection should be as listed.	

Voltmeter Calibrator Volts Peak-to-Peak	VOLTS/CM Setting	Vertical Deflection
0.03	.005	6 cm ± 1.8 mm
0.05	.01	5 cm ± 1.5 mm
0.1	.02	5 cm ± 1.5 mm
0.3	.05	6 cm ± 1.8 mm
0.5	.1	5 cm ± 1.5 mm
1	.2	5 cm ± 1.5 mm
3	.5	6 cm ± 1.8 mm
5	1	5 cm ± 1.5 mm
10	2	5 cm ± 1.5 mm
30	5	6 cm ± 1.5 mm
50	10	5 cm ± 1.5 mm
100	20	5 cm ± 1.5 mm

TABLE 5-4. (Continued)

STEP NO.	ACTION REQUIRED	PERFORMANCE STANDARDS
3	Set vertical DISPLAY to B and center trace with B POSTION.	
4	Disconnect Voltmeter Calibrator output from A INPUT connector and connect to B INPUT connector.	
5	Set Voltmeter Calibrator output and channel B VOLTS/CM as listed in step 2 and observe vertical trace in each position. Vertical deflection should be within the range listed in step 2.	
6	Rotate channel B vernier VOLTS/CM fully ccw.	Vertical deflection less than 2 cm.
7	Set vertical DISPLAY to A.	
8	Disconnect Voltmeter Calibrator output from B INPUT connector and connect to A INPUT connector.	
9	Rotate channel A vernier VOLTS/CM fully ccw.	Vertical deflection less than 2 cm.
10	Rotate channel A vernier VOLTS/CM fully cw to CAL.	
11	Set Voltmeter Calibrator output to 0.005 V and channel A VOLTS/CM to .005.	
12	Set Vertrical MAGNIFIER to X5	Vertical deflection 5 cm ± 1.5 mm
13	Set vertical MAGNIFIER to X1.	
14	Disconnect Voltmeter Calibrator.	
15	Connect a 1 MHz signal from Constant Amplitude Signal Generator through a 50-ohm termination and tee-connector to A and B INPUT connectors.	
16	Set channel A and B VOLTS/CM to .05 and vernier VOLTS/CM to CAL.	
17	Set channel A and B input coupling to GND and adjust A POSITION to place time base exactly on center horizontal graticule.	
18	Set vertical DISPLAY to B and adjust B POSITION to place time base exactly on center horizontal graticule.	
19	Set vertical DISPLAY to A and channel A and B input coupling to AC.	

TABLE 5-4. (Continued)

STEP NO.	ACTION REQUIRED	PERFORMANCE STANDARDS
20	Adjust Signal Generator amplitude for 5 cm display.	
21	Set vertical DISPLAY to A+B, channel B POLARITY to -UP, and channel A and B VOLTS/CM to .005.	Vertical display less than 5 mm.
2		NOTE If vertical deflection is greater than 5 mm, adjust B CAL to obtain correct indication.
22	Disconnect Signal Generator.	
23	Set vertical controls as follows: Set vertical DISPLAY to A. Set channel B POLARITY to +UP. Set channel A and B VOLTS/CM to .5.	
24	Connect a 50 kHz signal from Constant Amplitude Signal Generator output through a 50-ohm termination and a tee-connector to the A INPUT connector.	
25	Adjust Signal Generator output amplitude for an 8 cm display. Measure and record Signal Generator output voltage at tee-connector with RF Millivoltmeter.	
26	Increase Signal Generator frequency to 50 MHz and adjust output to same voltage recorded in step 25.	Vertical deflection greater than 5.7 cm.
27	Disconnect Signal Generator from A INPUT connector and connect through a 50-ohm termination and tee-connector to B INPUT connector.	
28	Set vertical DISPLAY to B.	
29	Adjust Signal Generator for a 50 kHz output and repeat steps 25 and 26.	
30	Set main TIME/CM to .1 USEC and vertical DISPLAY to ALT B TRIGGER.	
31	Adjust Signal Generator output amplitude for 0.5 cm of vertical deflection on channel B.	
32	Adjust main TRIGGER LEVEL for stable display.	Stable display.
33	Set vertical DISPLAY to B and, if necessary, adjust main TRIGGER LEVEL.	Stable display.
34	Disconnect Signal Generator from B INPUT connector.	

TABLE 5-4. (Continued)

STEP NO.	ACTION REQUIRED	PERFORMANCE STANDARDS
35	Connect Oscillator output to B INPUT connector and set Oscillator to produce a 100 kHz signal.	
36	Set vertical DISPLAY to CHOP B TRIGGER and main TIME/CM to 10 USEC.	
37	Adjust Oscillator output amplitude for 0.5 cm of vertical deflection on channel B.	
38	Adjust main TRIGGER LEVEL for stable display.	Stable display.
39	Disconnect Oscillator from B INPUT connector.	
40	Set oscilloscope controls as follows: Set horizontal MAGNIFIER to X10. Set main TIME/CM to .1 USEC. Set vertical DISPLAY to A. Set channel A and B VOLTS/CM to .05	
41	Connect Pulse Generator output to A INPUT. Adjust main TRIGGER LEVEL for stable display.	
42	Adjust HORIZONTAL POSITION to observe leading edge of pulse. Readjust main TRIGGER LEVEL if necessary.	
43	Adjust A POSITION and A vernier VOLTS/CM for a centered 8 cm display.	
44	Observe rise time.	Rise time less than 7 nsec.
45	Set vertical DISPLAY to B.	
46	Disconnect Pulse Generator from A INPUT and connect to B INPUT connector.	
47	Adjust B POSITION and B vernier VOLTS/CM for a centered 8 cm display.	
48	Observe rise time.	Rise time less than 7 nsec.
49	Disconnect Pulse Generator.	

TABLE 5-5. TIME BASE AND DELAY GENERATOR REFERENCE STANDARDS PROCEDURE

STEP NO.	ACTION REQUIRED	PERFORMANCE STANDARDS
	Preliminary Set-Up	Test Equipment Required
	Lock plug-ins together and install in oscilloscope assembly. Set POWER switch on. After 15 minute warm-up period, perform turn-on and intensity ratio adjustment procedures listed in table 3-3. Set oscilloscope controls as follows: Set horizontal MAGNIFIER to X10. Set horizontal DISPLAY to INT. Set vertical DISPLAY to A. Set A POLARITY to +UP. Set A vernier VOLTS/CM to CAL. Set A VOLTS/CM to .1. Set A input coupling to AC. Set vertical MAGNIFIER to X1. Set sweep display to MAIN. Set SWEEP MODE to AUTO. Set CM DELAY to 1.00. Set MAIN VERNIER to CAL. Set main trigger source to EXT. Set main SLOPE to +. Set main trigger coupling to AC. Set main TIME/CM to .2 USEC. Set delayed TIME/CM to OFF. Set DELAYED VERNIER to CAL. Set delayed trigger source to AUTO. Set delayed SLOPE to +. Set delayed trigger coupling to AC.	Constant Amplitude Signal Generator, Type 191A Oscillator, 0-1025/U Time Mark Generator, Type 180 Oscilloscope, Model 140 with 1402A and 1420A 10:1 Divider Probe, Model 10001A Adapter, UG-273/U Adapter, UG-255/U Tee-Connector (2), UG-274B/U	
1	Connect Constant Amplitude Signal Generator output to channel A INPUT, main EXT INPUT and delayed EXT INPUT connectors. (Use two tee-connectors.)	
2	Set Signal Generator frequency to 50 MHz and output amplitude to 0.5 v peak-to-peak.	
3	Adjust INTENSITY and position controls to obtain display.	
4	Adjust main TRIGGER LEVEL.	Stable display.
5	Set sweep display to DELAYED and delayed TIME/CM to .1 USEC.	Stable display.
6	Set delayed trigger source to EXT.	
7	Adjust delayed TRIGGER LEVEL.	Stable display.
8	Set Signal Generator frequency to 90 MHz and output amplitude to 1 v peak-to-peak.	
9	Adjust delayed TRIGGER LEVEL.	Stable display.
10	Set delayed trigger source to AUTO.	Stable display.

TABLE 5-5. (Continued)

STEP NO.	ACTION REQUIRED	PERFORMANCE STANDARDS
11	Set sweep display to MAIN and delayed TIME/CM to OFF.	
12	Adjust main TRIGGER LEVEL.	Stable display.
13	Disconnect Signal Generator.	
14	Connect Oscillator output to channel A INPUT, main EXT INPUT and delayed EXT INPUT connectors. (Use two tee-connectors.)	
15	Set Oscillator frequency to 40 Hz and output amplitude to 5 v peak-to-peak.	
16	Set horizontal MAGNIFIER to X1, main TIME/CM to 5 MSEC and channel A VOLTS/CM to 1.	
17	Rotate main TRIGGER LEVEL fully cw, then fully ccw.	Stable display. Trigger point moves smoothly along positive slope of waveform as TRIGGER LEVEL is rotated.
18	Set main SLOPE to -.	
19	Rotate main TRIGGER LEVEL from fully ccw to fully cw.	Stable display. Trigger point moves smoothly along negative slope of waveform as TRIGGER LEVEL is rotated.
20	Set sweep display to DELAYED, delayed TIME/CM to 2 MSEC and delayed trigger source to EXT.	
21	Rotate delayed TRIGGER LEVEL fully cw, then fully ccw.	Stable display. Trigger point moves smoothly along positive slope of waveform as TRIGGER LEVEL is rotated.
22	Set delayed SLOPE to -.	
23	Rotate delayed TRIGGER LEVEL from fully ccw to fully cw.	Stable display. Trigger point moves smoothly along negative slope of waveform as TRIGGER LEVEL is rotated.

TABLE 5-5. (Continued)

STEP NO.	ACTION REQUIRED	PERFORMANCE STANDARDS
24	Disconnect Oscillator.	
25	Connect Time Mark Generator output to channel A INPUT connector.	
26	Set oscilloscope controls as follows: Set sweep display to MAIN. Set delayed TIME/CM to OFF. Set SWEEP MODE to NORM. Set main trigger source to INT. Set main SLOPE to +. Set channel A VOLTS/CM to .5.	
27	Set Time Mark Generator and main TIME/CM as listed below, and adjust main TRIGGER LEVEL for display. Adjust HORIZONTAL POSITION to align first marker with left edge of graticule. For each setting, the 11th or 21st marker (as listed) should be within 3 mm of right edge of graticule.	
	Set Time Mark Generator To: / Set Main TIME/CM To:	Time Mark within 3 mm of right graticule:
	10 MHz — .1 USEC	11th
	1 usec — 1 USEC	11th
	10 usec — 10 USEC	11th
	100 usec — .1 MSEC	11th
	1 msec — 1 MSEC	11th
	10 msec — 10 MSEC	11th
	10 msec — 20 MSEC	21st
	1 sec — 1 SEC	11th
28	Set Time Generator for 500 msec markers.	
29	Set main TIME/CM to 50 MSEC and rotate MAIN VERNIER fully ccw.	Two markers displayed within 4 cm.
30	Set Time Base controls as follows: Set MAIN VERNIER to CAL. Set main TIME/CM to .2 USEC. Set sweep display to DELAYED. Set delayed trigger source to INT. Set delayed SLOPE to +.	
31	Set Time Mark Generator and delayed TIME/CM as listed below, and adjust delayed TRIGGER LEVEL for display. Adjust HORIZONTAL POSITION to align first marker with left edge of graticule. For each setting the 11th or 21st marker (as listed) should be within 3 mm of right edge of graticule.	

TABLE 5-5. (Continued)

STEP NO.	ACTION REQUIRED	PERFORMANCE STANDARDS
	Set Time Mark Generator To: / Set delayed TIME/CM To:	Time Mark within 3 mm of right graticule:
	10 MHz — .1 USEC	11th
	1 usec — 1 USEC	11th
	10 usec — 10 USEC	11th
	100 usec — .1 MSEC	11th
	1 msec — 1 MSEC	11th
	1 msec — 2 MSEC	21st
	500 msec — 50 MSEC	11th
32	Set Time Mark Generator for 500 msec markers.	
33	Rotate DELAYED VERNIER fully ccw.	Two markers displayed within 4 cm.
34	Set Time Base Controls as follows: Set sweep display to MAIN. Set main TIME/CM to 1 MSEC. Set delayed TIME/CM to 10 USEC. Set delayed trigger source to AUTO.	
35	Set Time Mark Generator for 1 msec markers.	
36	Adjust main TRIGGER LEVEL for display.	
37	Adjust CM DELAY to intensify 2nd marker.	
38	Set sweep display to DELAYED and adjust CM DELAY to align visible marker with start of sweep.	
39	Record CM DELAY setting	CM DELAY_____
40	Set sweep display to MAIN and adjust CM DELAY to intensify 10th marker.	
41	Set sweep display to DELAYED and adjust CM DELAY to align visible marker with start of sweep.	
42	Record CM DELAY setting.	CM DELAY_____
43	Subtract setting recorded in step 39 from setting recorded in step 42.	Difference is 8.00 ± .08.
44	Rotate CM DELAY fully ccw to 0, then adjust CM DELAY cw to align first visible marker with start of sweep.	
45	Record CM DELAY setting.	CM DELAY_____
46	Adjust CM DELAY cw to align 5th visible marker with start of sweep.	
47	Record CM DELAY setting.	CM DELAY_____

TABLE 5-5. (Continued)

STEP NO.	ACTION REQUIRED	PREFORMANCE STANDARDS
48	Adjust CM DELAY cw to align 9th visible marker with start of sweep.	
49	Record CM DELAY setting.	CM DELAY_____
50	Calculate linearity as follows:	
	a. Subtract setting recorded in step 45 from setting recorded in step 49.	
	b. Divide difference obtained in step a by 2.	Quotient_____
	c. Add setting recorded in step 45 to quotient obtained in step b.	Sum_____
	d. Subtract setting recorded in step 47 from sum obtained in step c.	Difference_____
	e. Divide difference obtained in step d by 2 to obtain answer.	Answer: 0 ± .02.
51	Set delayed TIME/CM to 1 USEC.	
52	Adjust CM DELAY to view 9th visible marker.	Horizontal jitter less than 0.5 cm.
53	Connect Test Oscilloscope through a 10:1 Divider Probe to DELAYED TRIGGER OUTPUT.	
54	Observe pulse.	Pulse positive with greater than 1.5 volts amplitude. Rise time less than 50 msec.
55	Set Time Base Controls as follows: Set sweep display to MIXED. Set main TIME/CM to 1 MSEC. Set CM DELAY to 5.00.	
56	Observe trace.	First 5 cm (approximately) of display brighter than last 5 cm.
57	Disconnect Time Mark Generator.	
58	Set Time Base Controls as follows: Set sweep display to MAIN. Set SWEEP MODE to SINGLE. Set main TIME/CM to .1 SEC. Set delayed TIME/CM to OFF.	
59	Press RESET pushbutton.	RESET indicator lights.
60	Rotate main TRIGGER LEVEL while observing CRT screen.	Beam sweeps once. RESET indicator goes out at end of sweep.

5-5. OSCILLOSCOPE ASSEMBLY ADJUSTMENTS.

a. COVER REMOVAL. - To gain access to adjustments and test points, one or both of the oscilloscope side covers must be removed. When required by the procedure, remove side covers as follows:

(1) Insure that POWER switch is off.

(2) Lower tilt stand and set oscilloscope on end.

(3) Release 6 snap-fasteners (figure 5-1) on bottom of oscilloscope. (If only necessary to remove one side panel, release only the 3 snap-fasteners on the applicable side.)

(4) Release 3, 1/4-turn fasteners on applicable side of oscilloscope.

(5) Lift side cover from the bottom and rotate towards the top to remove.

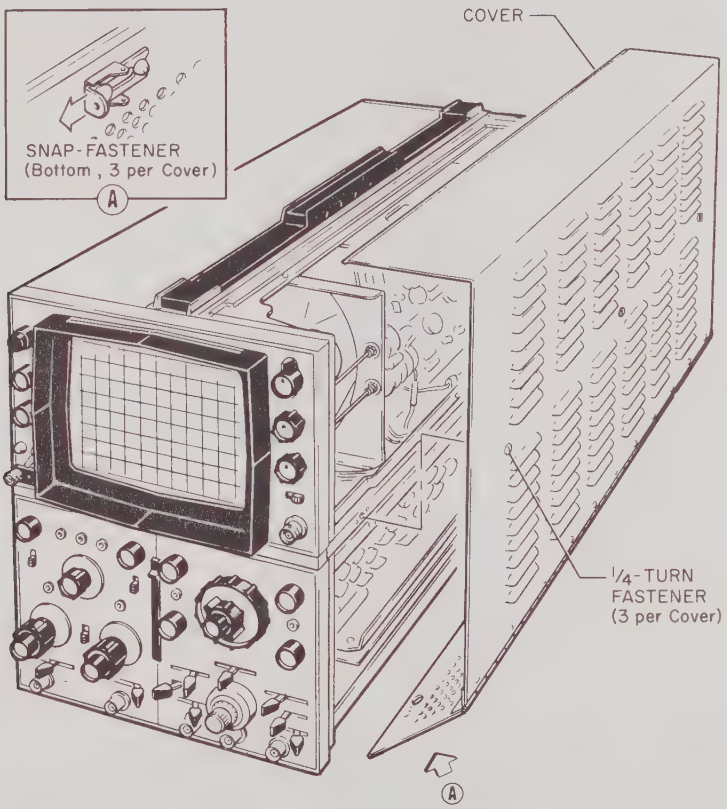


Figure 5-1. Oscilloscope Cover Removal

b. LOW VOLTAGE POWER SUPPLY ADJUSTMENT. - The low voltage power supply adjustment and test points are shown in figures 5-2, 5-19 and 5-30.

(1) TEST EQUIPMENT. - Digital Voltmeter, Model 3440A with 3441A.

(2) TEST SETUP.

(a) Remove oscilloscope right-hand cover per paragraph 5-5a.

(b) Install plug-ins in oscilloscope and set POWER switch on. Allow a 15 minute warm-up before proceeding.

(3) INSTRUCTIONS.

(a) Connect Digital Voltmeter to TP404 and adjust R449 to obtain a reading of -100 v ±0.01v.

(b) Connect Digital Voltmeter to TP401 and adjust R412 to obtain a reading of +100 v ±0.01 v.

(c) Connect Digital Voltmeter to TP403 and adjust R434 to obtain a reading of -12.6 v ±0.01 v.

(d) Connect Digital Voltmeter to TP402 and adjust R423 to obtain a reading of +15 v ±0.01 v.

(e) Disconnect Digital Voltmeter.

c. HIGH VOLTAGE POWER SUPPLY ADJUSTMENT. - The high voltage power supply adjustment and test points are shown in figures 5-2, 5-13 and 5-30.

(1) TEST EQUIPMENT.

(a) Electronic Voltmeter, ME-243/FQM.

(b) 100:1 Divider Probe, Model 11045A.

(2) TEST SETUP.

(a) Remove both oscilloscope covers per paragraphs 5-5a.

(b) Install plug-ins in oscilloscope and set POWER switch on. Allow a 15 minute warm-up

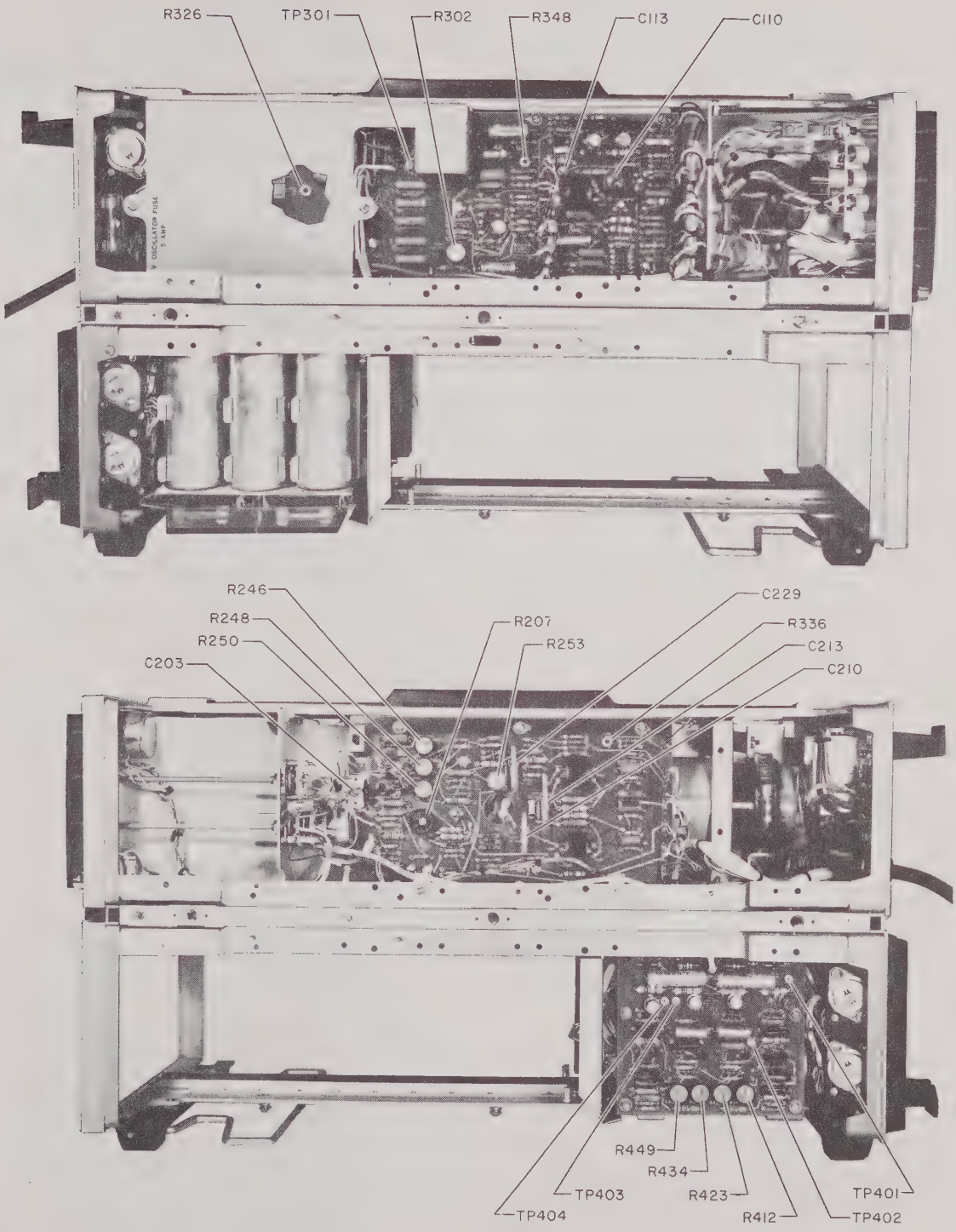


Figure 5-2. Oscilloscope Assembly Adjustments and Test Points

before proceeding.

(3) INSTRUCTIONS.

(a) Set Electronic Voltmeter to read approximately -1 vdc and connect voltmeter through a 100:1 Divider Probe to TP404.

(b) Divide voltmeter reading (approximately -1 vdc) by 100 and record result (should be approximately 0.01).

(c) Multiply -2950 by the result obtained in step b (should be approximately -29.5).

WARNING

High voltage is present at TP301. Use extreme caution while performing the following steps.

(d) Set Electronic Voltmeter to read a -30 vdc and connect voltmeter through a 100:1 Divider Probe to TP301.

(e) Adjust R302 to obtain voltage calculated in step c.

(f) Disconnect Electronic Voltmeter.

d. ASTIGMATISM ADJUSTMENT. - The astigmatism adjustment is performed with front-panel controls. These controls are shown in figure 3-1.

(1) INSTRUCTIONS.

(a) Install plug-ins in oscilloscope and set POWER switch on. Allow a 15 minute warm-up before proceeding.

(b) Set horizontal DISPLAY to EXT CAL and vertical DISPLAY to A.

(c) Set channel A input coupling to GND.

(d) Center spot with HORIZONTAL POSITION and A POSITION controls.

(e) Adjust FOCUS and ASTIGMATISM for a small round spot.

e. INTENSITY LIMIT ADJUSTMENT. - The intensity limit adjustment is shown in figures 5-2, 5-17 and 5-30.

(1) TEST SETUP.

(a) Remove oscilloscope left-hand cover per paragraph 5-5a.

(b) Install plug-ins in oscilloscope and set POWER switch on. Allow a 15 minute warm-up before proceeding.

(2) INSTRUCTIONS.

(a) Set sweep display to MAIN and delayed TIME/CM to OFF.

(b) Set INTENSITY control to "10 o'clock" position.

(c) Observe CRT and adjust R326 until trace just disappears.

f. FLOOD GUN ADJUSTMENT. - The flood gun adjustment is shown in figures 5-2, 5-13 and 5-30.

(1) TEST SETUP.

(a) Remove oscilloscope left-hand cover per paragraphs 5-5a.

(b) Install plug-ins in oscilloscope and set POWER switch on. Allow a 15 minute warm-up before proceeding.

(2) INSTRUCTIONS.

(a) Rotate INTENSITY full ccw and SCALE fully cw.

(b) Rotate R348 fully cw, then adjust R348 ccw until entire screen is at uniform intensity.

(c) Rotate SCALE fully ccw and insure that screen is not illuminated.

g. TRACE ALIGNMENT. - The trace alignment adjustment is shown in figures 5-2, 5-13 and 5-30.

(1) TEST SETUP.

(a) Remove oscilloscope right-hand cover per paragraph 5-5a.

(b) Install plug-ins in oscilloscope and set POWER switch on. Allow a 15 minute warm-up before proceeding.

(2) INITIAL CONTROL SETTINGS.

(a) Set horizontal MAGNIFIER to X1.

(b) Set horizontal DISPLAY to EXT CAL.

(c) Set horizontal coupling to AC.

(d) Set vertical DISPLAY to A.

(e) Set vertical MAGNIFIER to X1.

(f) Set channel A VOLTS/CM to 1 and vernier VOLTS/CM to CAL.

(g) Set channel A input coupling to GND.

(3) INSTRUCTIONS.

(a) Connect CALIBRATOR 10V output to horizontal EXT INPUT.

(b) Adjust INTENSITY for normal trace, and center trace with HORIZONTAL POSITION and A POSITION controls.

(c) Adjust TRACE ALIGN to align trace parallel with center horizontal graticule line.

(d) Disconnect CALIBRATOR 10V output from horizontal EXT INPUT.

(e) Set channel A input coupling to AC and connect CALIBRATOR 10V output to channel A INPUT.

(f) Center trace with HORIZONTAL POSITION.

(g) Adjust R336 to align trace parallel with center vertical graticule line.

(h) Disconnect CALIBRATOR 10V output from channel A INPUT.

h. GATE AMPLIFIER RESPONSE ADJUSTMENT. - The gate amplifier response adjustment and test points are shown in figures 5-2, 5-13 and 5-30.

(1) TEST EQUIPMENT.

(a) Oscilloscope, Model 140A with 1420A and 1402A.

(b) 10:1 Divider Probe, Model 10001A.

(2) TEST SETUP.

(a) Remove oscilloscope left-hand cover per paragraph 5-5a.

(b) Install plug-ins in oscilloscope and set POWER switch on. Allow a 15 minute warm-up before proceeding.

(3) CONTROL SETTINGS.

(a) Set AN/USM-281 Oscilloscope controls as follows:

Set horizontal DISPLAY to INT.
Set MAIN VERNIER to CAL.
Set main TIME/CM to .1 USEC.
Set SWEEP MODE to AUTO.
Set sweep display to MAIN.
Set delayed TIME/CM to OFF.

(b) Set Test Oscilloscope controls as follows:

Set volts/cm to 1.
Set time/cm to 0.1 usec.
Set trigger source to internal.
Set trigger slope to positive.

(4) INSTRUCTIONS.

(a) Connect Test Oscilloscope through a 10:1 Divider Probe to collector of Q103. (See figures

5-2 and 5-13.)

(b) Observe Test Oscilloscope and adjust C110 and C113 for fastest rise time and a flat response.

(c) Disconnect Test Oscilloscope.

i. HORIZONTAL AMPLIFIER DC BALANCE ADJUSTMENT. - The horizontal amplifier dc balance adjustment is shown in figures 5-2, 5-15 and 5-30.

(1) TEST SETUP.

(a) Remove oscilloscope right-hand cover per paragraph 5-5a.

(b) Install plug-ins in oscilloscope and set POWER switch on. Allow a 15 minute warm-up before proceeding.

(2) INSTRUCTIONS.

(a) Set vertical DISPLAY to A.

(b) Set horizontal DISPLAY to EXT CAL.

(c) Set channel A and B input coupling to GND.

(d) Center spot vertically with A POSITION.

(e) Set horizontal MAGNIFIER to X10.

(f) Center spot with HORIZONTAL POSITION controls.

(g) Set horizontal MAGNIFIER to X1 and recenter spot with R253.

(h) Repeat steps e through g until the spot does not shift position when the horizontal MAGNIFIER is switched from X10 to X1.

j. HORIZONTAL AMPLIFIER VERNIER BALANCE ADJUSTMENT. - The horizontal amplifier vernier balance adjustment is shown in figures 5-2, 5-15 and 5-30.

(1) TEST SETUP.

(a) Remove Oscilloscope right-hand cover per paragraph 5-5a.

(b) Install plug-ins in oscilloscope and set POWER switch on. Allow a 15 minute warm-up before proceeding.

(2) INSTRUCTIONS.

(a) Set horizontal MAGNIFIER to X10.

(b) Set horizontal DISPLAY to EXT SENS.

(c) Set channel A and B input coupling to GND.

(d) Set vertical DISPLAY to A and center spot vertically with A POSITION.

(e) Rotate horizontal DISPLAY fully ccw until the INT switch is felt. Do not engage the INT switch.

(f) Center spot with HORIZONTAL POSITION controls.

(g) Rotate horizontal DISPLAY cw to EXT CAL and recenter spot with R207.

(h) Repeat steps e through g until spot does not shift when horizontal DISPLAY is rotated between fully ccw position (not in INT) and the EXT CAL position.

k. HORIZONTAL AMPLIFIER GAIN ADJUSTMENT. - The horizontal amplifier gain adjustments are shown in figures 5-2, 5-3, 5-15 and 5-30.

(1) EQUIPMENT REQUIRED.

(a) Digital Ammeter, Model 3440A with 3444A.

(b) Resistor, variable from 40k ohms to 400k ohms.

(2) TEST SETUP.

(a) Remove oscilloscope right-hand cover per paragraph 5-5a.

(b) Install plug-ins in oscilloscope and set POWER switch on. Allow a 15 minute warm-up before proceeding.

(3) INSTRUCTIONS.

(a) Set horizontal DISPLAY to EXT CAL and horizontal MAGNIFIER to X1.

(b) Set vertical DISPLAY to A, and A input coupling to GND.

(c) Use HORIZONTAL POSITION and A POSITION controls to center spot on left edge of graticule.

WARNING

A voltage of +100 vdc is present on L201. Exercise care while performing the remaining steps.

Before performing step d, insure that digital ammeter negative (-) lead is isolated from ground to prevent damage to equipment.

(d) Set Variable Resistor for maximum resistance and connect Variable Resistor and Digital Ammeter in series from L201 to R216 as shown in figure 5-3.

(e) Observe Digital Ammeter and slowly adjust Variable Resistor to obtain a reading of 2.5 ma.

(f) Spot should be at right edge of CRT graticule. If spot is not at right edge adjust R250 to take up 1/2 difference between the spot and the right edge of graticule.

(g) Disconnect Digital Ammeter test lead from R216 and readjust HORIZONTAL POSITION to place spot on left edge of graticule.

(h) Reconnect Digital Ammeter test lead to R216 and repeat steps f through h until spot deflects 10 cm.

NOTE

If R250 can not be adjusted to obtain 10 cm of deflection and the CRT has been replaced, it may be necessary to select a new value for R251.

(i) Disconnect Digital Ammeter test lead from R216 and set horizontal MAGNIFIER to X5.

(j) Readjust HORIZONTAL POSITION to place spot on left edge of graticule.

(k) Reconnect Digital Ammeter test lead to R216 and readjust Variable Resistor (increase resistance) to obtain a reading of 0.5 ma.

(l) If spot is not at right edge of graticule adjust R248 to take up 1/2 the difference between the spot and the right edge of graticule.

(m) Disconnect Digital Ammeter test lead from R216 and readjust HORIZONTAL POSITION to place spot on left edge of graticule.

(n) Reconnect Digital Ammeter test lead to R216 and repeat steps l through n until spot deflects 10 cm.

(o) Disconnect Digital Ammeter test lead from R216 and set horizontal MAGNIFIER to X10.

(p) Readjust HORIZONTAL POSITION to place spot on left edge of graticule.

(q) Reconnect Digital Ammeter test lead to R216 and readjust Variable Resistor (increase resistance) to obtain a reading of 0.25 ma.

(r) If spot is not at right edge of graticule adjust R246 to take up 1/2 the difference between the spot and the right edge of graticule.

(s) Disconnect Digital Ammeter test lead from R216 and readjust HORIZONTAL POSITION to place spot on left edge of graticule.

(t) Reconnect Digital Ammeter test lead to R216 and repeat steps r through t until spot deflects 10 cm.

(u) Disconnect Digital Ammeter and Variable Resistor.

l. HORIZONTAL AMPLIFIER TRANSIENT RESPONSE ADJUSTMENT. - The horizontal amplifier transient response adjustments are shown in figures 5-2, 5-15, and 5-30.

(1) TEST EQUIPMENT.

(a) Oscilloscope, AN/USM-281.

(b) Square Wave Generator, Model 211A.

(c) Constant Amplitude Signal Generator, Type 191A.

(d) Tee-Connector, UG-274B/U.

(2) TEST SETUP.

(a) Remove oscilloscope right-hand cover per paragraph 5-5a.

(b) Install plug-ins in oscilloscope and set POWER switch on. Allow a 15 minute warm-up before proceeding.

(3) INITIAL CONTROL SETTINGS.

(a) Set AN/USM-281 Oscilloscope controls as follows:

Set vertical DISPLAY to A.
Set channel A POLARITY TO + UP.

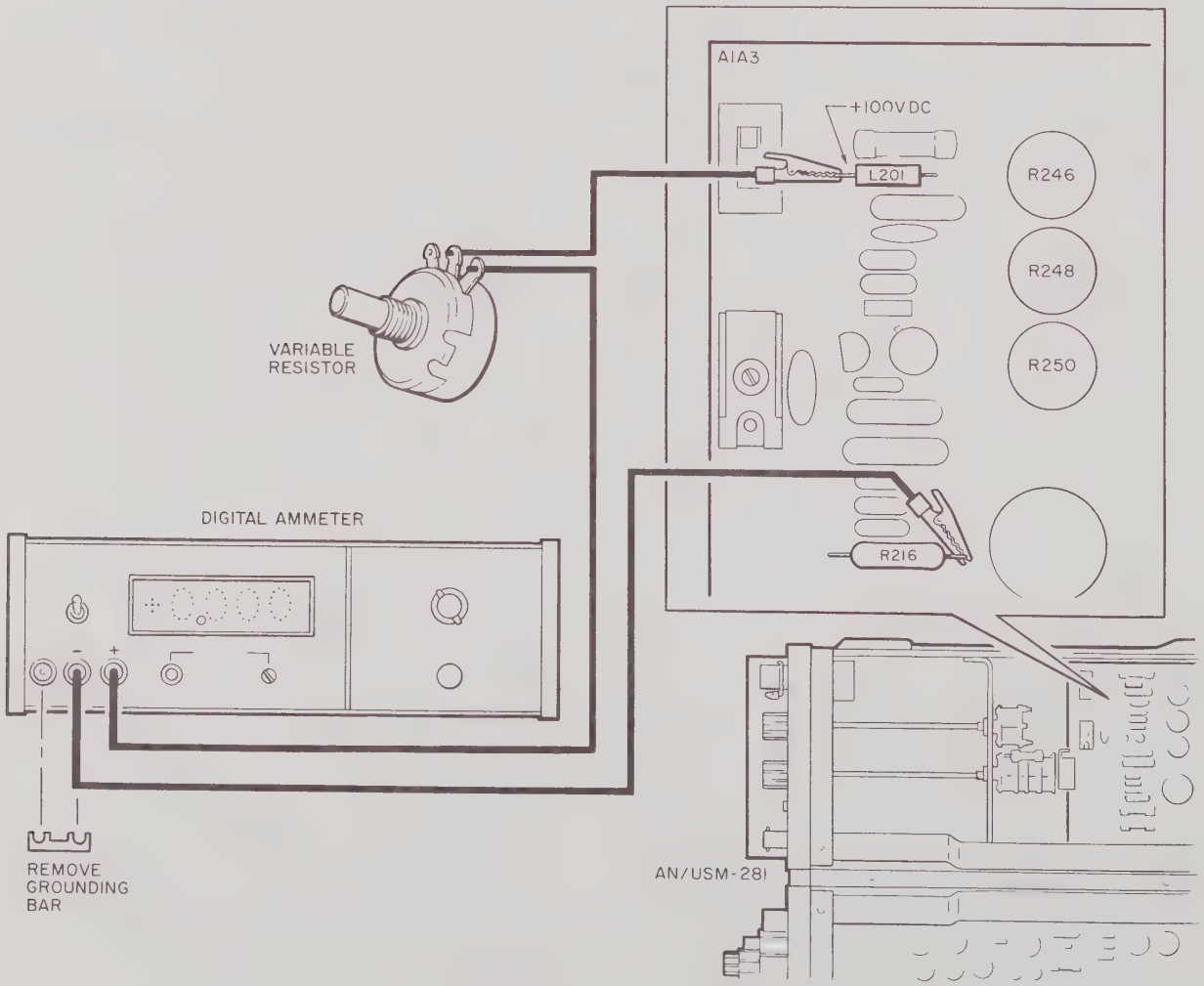


Figure 5-3. Horizontal Amplifier Gain Adjustment Test Setup

Set channel A input coupling to AC.
Set vertical MAGNIFIER to X1.
Set horizontal DISPLAY to EXT CAL.
Set horizontal MAGNIFIER to X10.
Set horizontal coupling to AC.

(b) Set Test Oscilloscope sweep speed to 1 usec/cm.

(4) INSTRUCTIONS.

(a) Connect Test Oscilloscope sweep output to channel A INPUT. See figure 5-4.

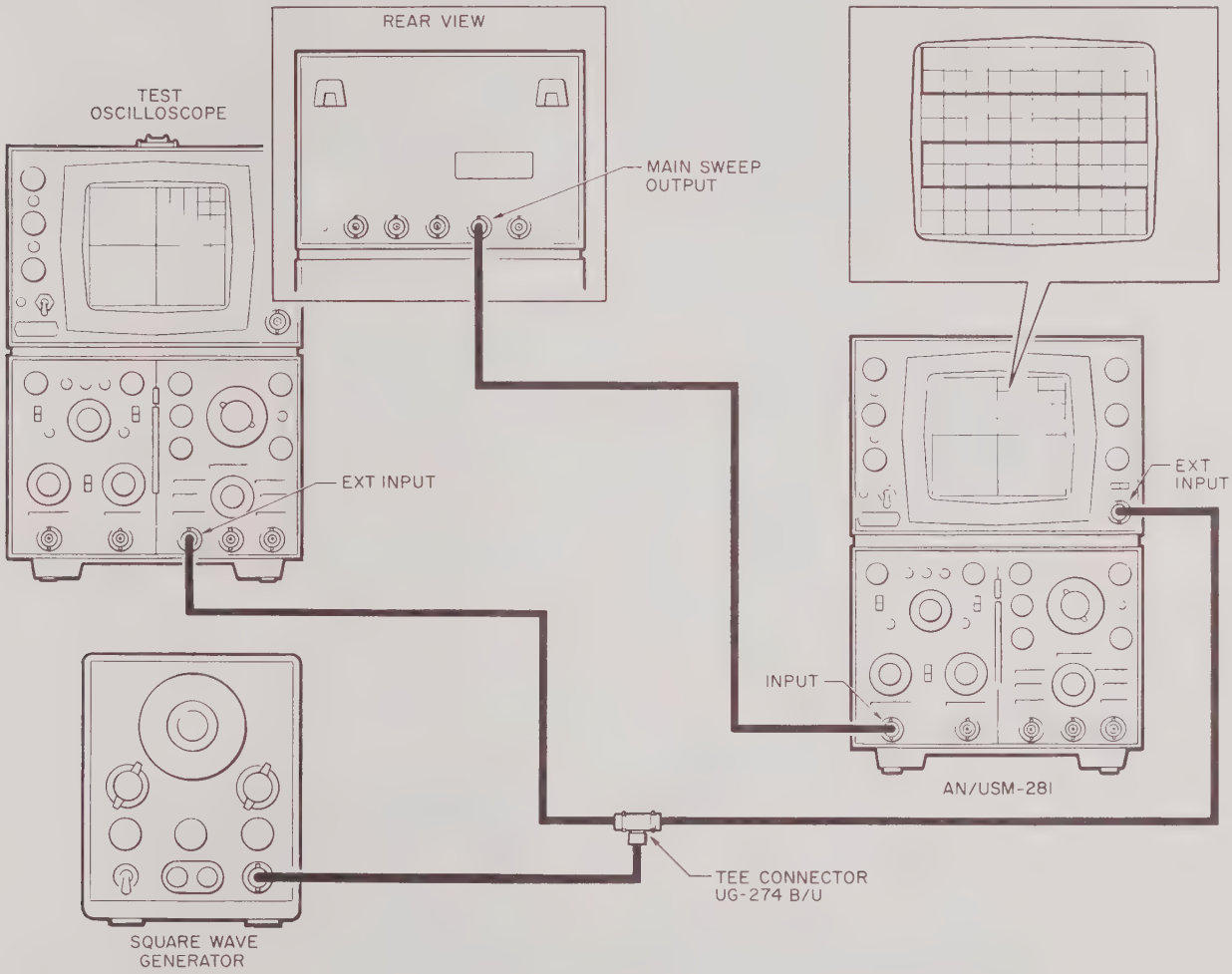


Figure 5-4. Horizontal Amplifier Transient Response Adjustment Test Setup

(b) Adjust channel A VOLTS/CM and vernier VOLTS/CM to obtain an 8 cm display. Center trace with HORIZONTAL POSITION and A POSITION controls.

(c) Set Square Wave Generator to a frequency of 200 kHz at 1 v peak-to-peak amplitude.

(d) Connect Square Wave Generator output (through tee-connector) to horizontal EXT INPUT connector.

(e) Synchronize Test Oscilloscope with 200 kHz signal.

(f) Observe waveform on AN/USM-281 Oscilloscope and adjust C210, C213 and C229 for best response on lower right-hand corner of wave. See figure 5-4.

NOTE

C210 and C229 should be adjusted so their slugs are almost equally extended.

(g) Disconnect Test Oscilloscope and Square Wave Generator and set horizontal DISPLAY to INT, channel A VOLTS/CM to 1 and channel A vernier VOLTS/CM to CAL.

(h) Connect Constant Amplitude Signal Generator output to channel A input and adjust Signal Generator to provide a 50 MHz sine wave at approximately 4 v peak-to-peak.

(i) Set main TIME CM to .1 USEC and adjust main TRIGGER LEVEL for stable display.

(j) Readjust C229 to display one cycle in 20 nsec (2 cm).

(k) Disconnect Constant Amplitude Signal Generator.

m. HORIZONTAL AMPLIFIER PHASE ADJUSTMENT. - The horizontal amplifier phase adjustment is shown in figures 5-2, 5-15 and 5-30.

(1) TEST EQUIPMENT.

(a) Oscillator, 0-1025/U.

(b) Tee-Connector, UG-274B/U.

(2) TEST SETUP.

(a) Remove oscilloscope right-hand cover per paragraph 5-5a.

(b) Install plug-ins in oscilloscope and set POWER switch on. Allow a 15 minute warm-up before proceeding.

(3) CONTROL SETTINGS.

(a) Set vertical DISPLAY to A.

(b) Set channel A POLARITY to +UP.

(c) Set channel A input coupling to AC.

(d) Set channel A VOLTS/CM to 1.

(e) Set vertical MAGNIFIER to X1.

(f) Set horizontal MAGNIFIER to X1.

(g) Set horizontal DISPLAY to EXT CAL.

(h) Set PHASE/BANDWIDTH to PHASE.

(4) INSTRUCTIONS.

(a) Connect Oscillator output to horizontal EXT INPUT and to channel A INPUT. (Use Tee-Connector.)

(b) Set Oscillator to produce a 100 kHz sine wave and adjust Oscillator amplitude to produce 8 cm of deflection.

(c) Observe CRT and adjust C203 for a single diagonal line (no phase shift).

(d) Disconnect Oscillator and set PHASE/BANDWIDTH to BANDWIDTH.

5-6. DUAL CHANNEL VERTICAL AMPLIFIER ADJUSTMENTS.

The dual channel vertical amplifier adjustments are performed with the plug-in units installed in the oscilloscope assembly. Allow a minimum of 15 minutes warm-up before performing these adjustments.

a. COVER REMOVAL. - To perform the adjustments on the dual channel vertical amplifier it is necessary to remove the oscilloscope left-hand cover. Remove the left-hand cover as described in paragraph 5-5a.

b. EXTENDING PLUG-IN UNITS. - To gain access to some of the adjustments on the dual channel vertical amplifier it is necessary to extend the plug-in units. When required by the adjustment procedure, extend the plug-ins as follows:

(1) Insure that POWER switch is off.

(2) Lift latch release and rotate handle downward, away from panel. See figure 2-1.

(3) Using latch handle, pull plug-in assemblies from oscilloscope assembly.

(4) Insert plug-in extender into oscilloscope assembly and mate with internal connector. See figure 5-5.

(5) Insert plug-in units into plug-in extender.

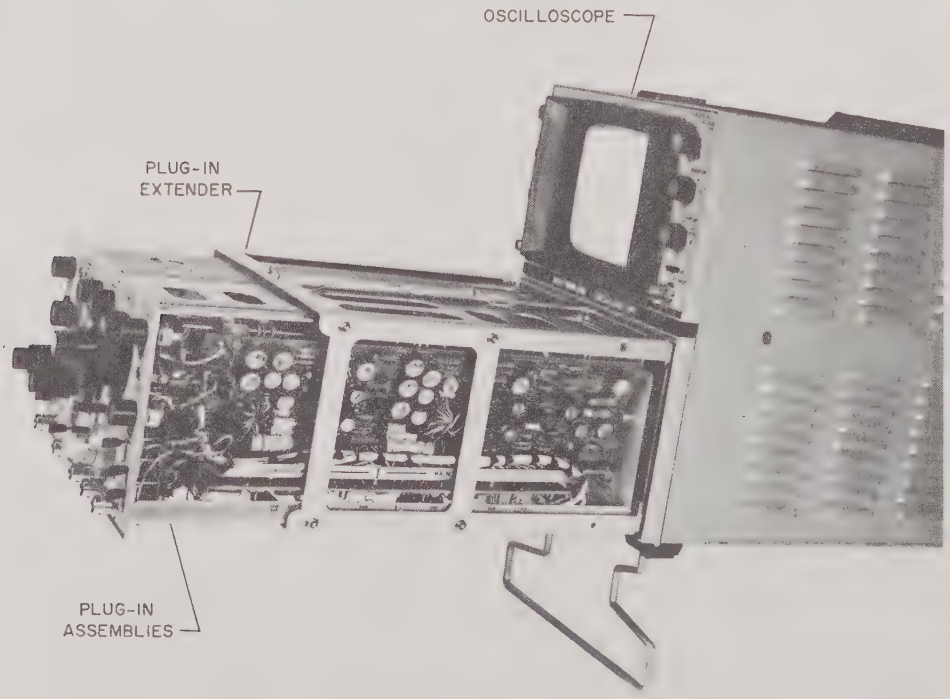


Figure 5-5. Plug-In Extender Installation

c. CONTROL SETTINGS. - Unless otherwise instructed, perform all adjustments on the dual channel vertical amplifier with the oscilloscope controls set to the positions shown in table 5-6.

TABLE 5-6. CONTROL SETTINGS FOR DUAL CHANNEL VERTICAL AMPLIFIER ADJUSTMENTS

CONTROL	SETTING	CONTROL	SETTING
Horizontal MAGNIFIER	X1	Sweep display	MAIN
Horizontal DISPLAY	INT	SWEEP MODE	AUTO
POLARITY (A and B)	+UP	MAIN VERNIER	CAL
Vernier VOLTS/CM (A and B)	CAL	Main trigger source	INT
VOLTS/CM (A and B)	.005	Main SLOPE	+
Input coupling (A and B)	GND	Main trigger coupling	AC
Vertical MAGNIFIER	X1	Main TIME/CM	2 MSEC
		Delayed TIME/CM	OFF

d. AMPLIFIER BALANCE AND DC LEVEL ADJUSTMENT. - The amplifier balance and dc level adjustment and test points are shown in figures 5-6, 5-22 and 5-31.

(1) TEST EQUIPMENT. Multimeter, AN/USM-183.

(2) INSTRUCTIONS.

(a) Adjust oscilloscope controls to produce a centered trace of normal intensity.

(b) Adjust DC BAL A for less than 2 mm vertical shift of baseline when A POLARITY is switched between +UP and -UP. See table 3-3 for this adjustment.

(c) Adjust A POSITION to place baseline exactly on center graticule.

(d) Set Multimeter to read -10 vdc.

(e) Using Multimeter, monitor voltage at collector of Q303.

(f) Adjust R303 to obtain a reading of -7.3 vdc.

(g) Adjust R317 for less than 2 mm vertical shift of baseline while rotating channel A vernier VOLTS/CM from one extreme to the other.

(h) Repeat steps b and g until no further adjustment is required.

(i) Set vertical DISPLAY to B and adjust DC BAL B for less than 2 mm vertical shift of baseline when B POLARITY is switched between +UP and -UP. See table 3-3 for this adjustment.

(j) Adjust B POSITION to place baseline exactly on center graticule.

(k) Using Multimeter, monitor voltage at collector of Q403.

(l) Adjust R403 to obtain a reading of -7.3 vdc.

(m) Adjust R417 for less than 2 mm vertical shift of baseline while rotating channel B vernier VOLTS/CM from one extreme to the other.

(n) Repeat steps i and m until no further adjustment is required.

e. GAIN ADJUSTMENT. - The gain adjustment is performed with front-panel controls. These controls are shown in figure 3-1.

(1) TEST EQUIPMENT. Voltmeter Calibrator, Model 738AR/BR.

(2) INSTRUCTIONS.

(a) Set channel A and B input coupling to DC.

(b) Adjust Voltmeter Calibrator to produce a 400 Hz signal at 30 mv peak-to-peak and connect Voltmeter Calibrator output to channel A INPUT.

(c) Adjust main TRIGGER LEVEL for stable display.

(d) Adjust A CAL for a 6 cm display.

(e) Disconnect Voltmeter Calibrator from A INPUT and connect to B INPUT.

(f) Set vertical DISPLAY to B.

(g) Adjust B CAL for a 6 cm display.

(h) Disconnect Voltmeter Calibrator.

f. B TRIGGER BALANCE ADJUSTMENT. - The B trigger balance adjustment and test points are shown in figures 5-6, 5-25 and 5-31.

(1) TEST EQUIPMENT. Multimeter, AN/USM-183.

(2) INSTRUCTIONS.

(a) Set vertical DISPLAY to ALT B TRIGGER.

(b) Adjust B POSITION to place channel B baseline exactly on center graticule.

(c) Set Multimeter to read a low dc voltage and connect multimeter to TP701 and TP702.

(d) Adjust R729 to obtain a Multimeter reading of 0 vdc.

(e) Disconnect Multimeter.

g. TRIGGER OUTPUT LEVEL ADJUSTMENT. - The trigger output level adjustment and test points are shown in figures 5-6, 5-25 and 5-31.

(1) TEST EQUIPMENT. Multimeter, AN/USM-183.

(2) INSTRUCTIONS.

(a) Remove oscilloscope right-hand cover per paragraph 5-5a.

(b) Set vertical DISPLAY to ALT B TRIGGER.

(c) Adjust B POSITION to place channel B baseline exactly on center graticule.

(d) Set Multimeter to read a low dc voltage and connect Multimeter to R110 as shown in figure 5-7.

(e) Adjust R751 to obtain a reading of 0 vdc.

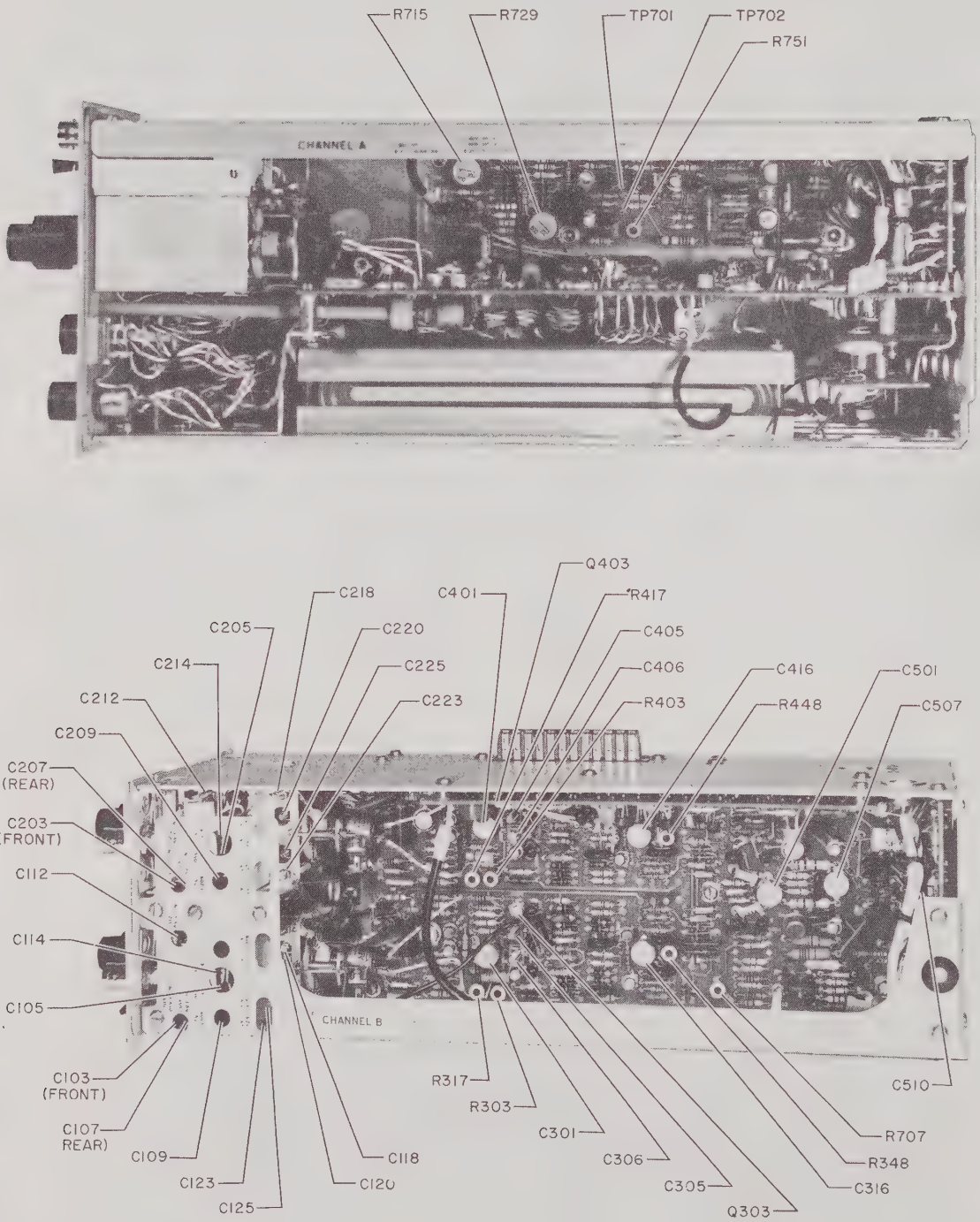


Figure 5-6. Dual Channel Vertical Amplifier Adjustments and Test Points

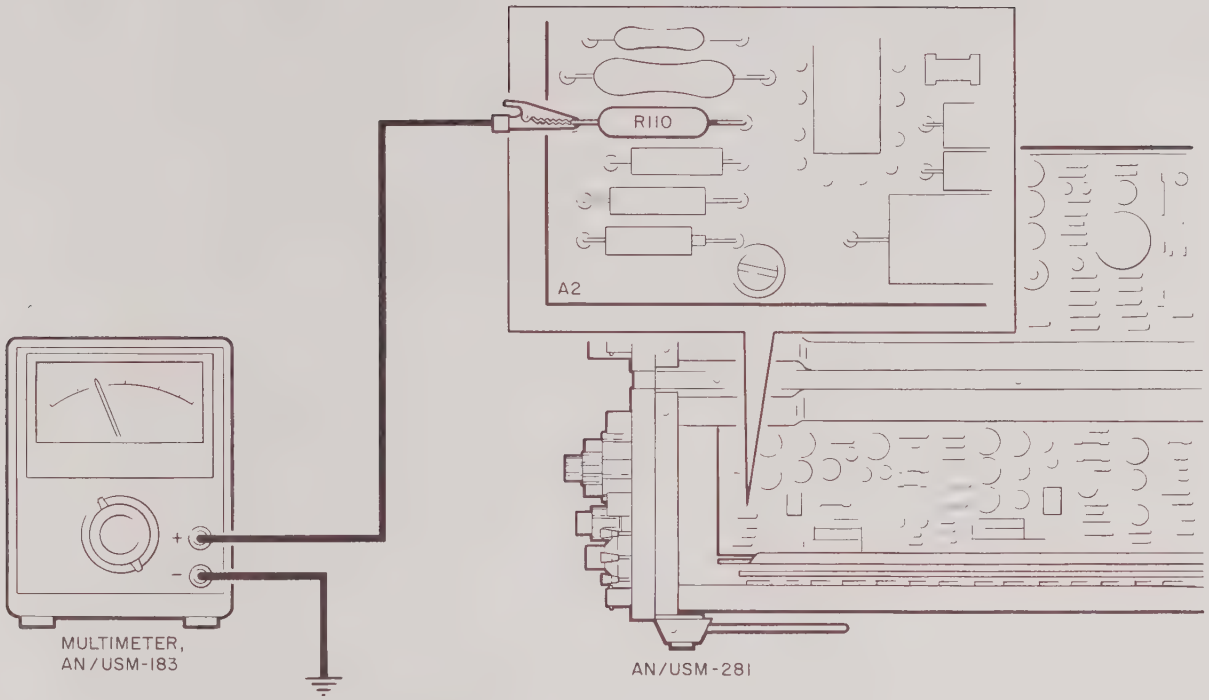


Figure 5-7. Trigger Output Level Adjustment Test Setup

h. COMPOSITE TRIGGER BALANCE ADJUSTMENT. - The composite trigger balance adjustment and test points are shown in figures 5-6, 5-25 and 5-31.

(1) TEST EQUIPMENT. Multimeter, AN/USM-183.

(2) INSTRUCTIONS.

(a) Set vertical DISPLAY to B.

(b) Adjust B POSITION to place baseline exactly on center graticule.

(c) Set Multimeter to read a low dc voltage and connect Multimeter to TP701 and TP702.

(d) Adjust R715 to obtain a multimeter reading of 0 vdc.

(e) Disconnect Multimeter.

i. COMPOSITE INVERTER CURRENT ADJUSTMENT. - The composite inverter current adjustment and test points are shown in figures 5-6, 5-22 and 5-31.

(1) TEST EQUIPMENT. Multimeter, AN/USM-183.

(2) INSTRUCTIONS.

(a) Remove oscilloscope right-hand cover per paragraph 5-5a.

(b) Set vertical DISPLAY to B.

(c) Adjust B POSITION to place baseline exactly on center graticule.

(d) Set Multimeter to read +5 vdc and connect Multimeter to TP701.

(e) Adjust R707 to obtain a Multimeter reading of +5 vdc.

(f) Adjust B POSITION to place baseline exactly on center graticule.

(g) Disconnect Multimeter from TP701 and connect to R110 as shown in figure 5-7.

(h) Readjust R707 to obtain a Multimeter reading of 0 vdc.

(i) Disconnect Multimeter.

j. DELAY LINE TERMINATION ADJUSTMENT. - The delay line termination adjustment is shown in figures 5-6, 5-22 and 5-31.

(1) TEST EQUIPMENT. Square Wave Generator, Model 211B.

(2) CONTROL SETTINGS. Reset following controls:

(a) Set horizontal MAGNIFIER to X5.

(b) Set main TIME/CM to .1 USEC.

(c) Set channel A VOLTS/CM to .05.

(d) Set channel A INPUT coupling to DC.

(3) INSTRUCTIONS.

(a) Connect Square Wave Generator output to channel A INPUT and adjust Square Wave Generator to provide a 100 kHz, 0.3 v peak-to-peak output.

(b) Adjust main TRIGGER LEVEL for display.

(c) Adjust HORIZONTAL POSITION to observe leading edge of pulse. Readjust main TRIGGER LEVEL if necessary.

(d) Adjust Square Wave Generator output amplitude and channel A vernier VOLTS/CM to obtain a 6 cm display.

(e) Adjust C501 to reduce reflection (re-

flection is 8 cm from leading edge of pulse) to one baseline width.

(f) Disconnect Square Wave Generator.

k. ATTENUATOR COMPENSATION ADJUSTMENT. - The attenuator compensation adjustments are shown in figures 5-6, 5-20, 5-21 and 5-31.

(1) TEST EQUIPMENT. Square Wave Generator, Model 211B.

(2) TEST SETUP.

(a) Set oscilloscope POWER switch off and extend plug-in units per paragraph 5-6b.

(b) Set oscilloscope POWER switch on and allow 15 minute warm-up before proceeding.

(3) CONTROL SETTINGS. Reset following controls:

(a) Set main TIME/CM to 20 USEC.

(b) Set Channel A and B input coupling to AC.

(4) INSTRUCTIONS.

(a) Connect square Wave Generator output to channel A INPUT and adjust generator to provide a 10 kHz square wave.

(b) Set channel A VOLTS/CM to each of the settings listed in table 5-7. At each setting, adjust Square Wave Generator output to produce a 6 cm display and adjust main TRIGGER LEVEL for a stable display. Observe CRT and adjust the appropriate channel A capacitor listed in table 5-7 to obtain best square wave response.

TABLE 5-7. ATTENUATOR COMPENSATION ADJUSTMENTS

VOLTS/CM SETTINGS	CHANNEL A ADJUSTMENTS	CHANNEL B ADJUSTMENTS
.01	C120	C220
.02	C125	C225
.05	C105	C205
.1	C118	C218
.2	C123	C223
.5	C109	C209
5	C114	C214

(c) Set vertical DISPLAY to B.

(d) Disconnect Square Wave Generator. from channel A INPUT and connect to channel B INPUT.

(e) Set channel B VOLTS/CM to each of the settings listed in table 5-7. At each setting adjust Square Wave Generator output to produce a 6 cm display and adjust main TRIGGER LEVEL for a stable display. Observe CRT and adjust the appropriate channel B capacitor listed in table 5-7 to obtain best square wave response.

(f) Disconnect Square Wave Generator.

l. INPUT CAPACITANCE ADJUSTMENT. - The input capacitance adjustments are shown in figures 5-6, 5-20, 5-21 and 5-31.

(1) TEST EQUIPMENT. LC meter, Type 130.

(2) TEST SETUP.

(a) Set oscilloscope POWER switch off and extend plug-in units per paragraph 5-6b.

(b) Set oscilloscope POWER switch on and allow 15 minute warm-up before proceeding.

(3) INSTRUCTIONS.

(a) Set channel A and B input coupling to DC.

(b) Connect LC meter to channel A INPUT.

(c) Measure and record input capacitance.

(d) Set channel A VOLTS/CM to .05 and adjust C103 to obtain same capacitance reading recorded in step c.

(e) Set channel A VOLTS/CM to .5 and adjust C107 to obtain same capacitance reading recorded in step c.

(f) Set channel A VOLTS/CM to 5 and adjust C112 to obtain same capacitance reading recorded in step c.

(g) Set vertical DISPLAY to B.

(h) Disconnect LC Meter from A INPUT and connect to B INPUT.

(i) Measure and record input capacitance.

(j) Set channel B VOLTS/CM to .05 and adjust C203 to obtain same capacitance reading recorded in step i.

(k) Set channel B VOLTS/CM to .5 and adjust C207 to obtain same capacitance reading recorded in step i.

(l) Set channel B VOLTS/CM to 5 and adjust C212 to obtain same capacitance reading recorded in step i.

(m) Disconnect LC Meter.

m. PULSE RESPONSE ADJUSTMENT. - The pulse response adjustments are shown in figures 5-6, 5-22 and 5-31.

(1) TEST EQUIPMENT.

(a) Pulse Generator, 8000A.

(b) Constant Amplitude Signal Generator, Type 191A.

(c) RF Millivoltmeter, AN/URM-155.

(d) Tee-Connector, UG-274B/U.

(2) CONTROL SETTINGS. Reset following controls:

(a) Set main TIME/CM to .1 USEC.

(b) Set channel A and B input coupling to DC.

(c) Set vertical DISPLAY to ALT.

(3) INSTRUCTIONS.

(a) Connect Pulse Generator output through Tee-Connector to A INPUT and B INPUT.

(b) Adjust Pulse Generator output amplitude and channel A and B vernier VOLTS/CM for a 4 cm vertical display on each channel. Readjust A and B POSITION as required.

(c) Adjust main TRIGGER LEVEL for a stable display.

(d) Completely uncalibrate each channel by adjusting for the smoothest, roundest pulse possible. See figure 5-8. Adjust in this order: C301, C316, then R348 for channel A; C401, C416, then R448 for channel B; and C501, C507, then C510 for both channels.

(e) Now calibrate both channels by adjusting for the sharpest, flattest pulse possible (figure 5-8). Adjust in this order: C510, C507, then C501 (both channels); R348, C316, then C301 for channel A; and R448, C416, then C401 for channel B.

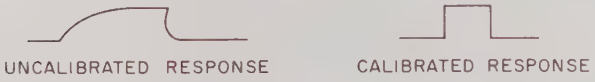


Figure 5-8. Pulse Response Adjustment Waveforms

NOTE

C501, C507, and C510 are common to both channels. Make these adjustments so that channel A response resembles (as close as possible) channel B response. C510 has most affect on rise time. Adjust C510 for fastest rise time and pulse response will be good.

(f) Further adjust for a flat, fast rising pulse by adjusting C305 and C306 for channel A, and C405 and C406 for channel B.

(g) Check channel A and B bandwidth per table 5-4.

NOTE

If bandwidth does not meet performance standards it may be necessary to slightly readjust R348 (channel A) or R448 (channel B). C316 (channel A) and C416 (channel B) have a lesser affect on bandwidth.

5-7. TIME BASE AND DELAY GENERATOR ADJUSTMENTS.

The time base and delay generator adjustments are performed with the plug-in units installed in the oscilloscope assembly. Allow a minimum of 15 minutes warm-up before performing these adjustments.

a. COVER REMOVAL. - To perform the adjustments on the time base and delay generator it is necessary to remove the oscilloscope right-hand cover. Remove the right-hand cover as described in paragraph 5-5a.

b. CONTROL SETTINGS. - Unless otherwise instructed, perform all adjustments on the time base and delay generator with the oscilloscope controls set to the positions shown in table 5-8.

c. MAIN OUTPUT LEVEL ADJUSTMENT. - The main output level adjustment and test points are shown in figures 5-9, 5-27 and 5-32.

(1) TEST EQUIPMENT. Multimeter, AN/USM-183.

(2) INSTRUCTIONS.

(a) Set SWEEP MODE to SINGLE.

TABLE 5-8. CONTROL SETTINGS FOR TIME BASE AND DELAY GENERATOR ADJUSTMENTS

CONTROL	SETTING	CONTROL	SETTING
Horizontal MAGNIFIER	X1	CM DELAY	1.00
Horizontal DISPLAY	INT	MAIN VERNIER	CAL
Vertical DISPLAY	A	Main trigger source	INT
Vertical MAGNIFIER	X1	Main SLOPE	+
A POLARITY	+UP	Main trigger coupling	AC
A vernier VOLTS/CM	CAL	Main TIME/CM	.5 MSEC
A VOLTS/CM	.5	Delayed TIME/CM	OFF
A input coupling	AC	DELAYED VERNIER	CAL
INTENS RATIO	Midrange	Delayed trigger source	INT
Sweep display	MAIN	Delayed SLOPE	+
SWEEP MODE	AUTO	Delayed trigger coupling	AC

(b) Set Multimeter to read low dc voltage and connect Multimeter to ~~TP205~~ TP204.

(c) Adjust R238 to obtain a reading of 0 vdc.

(d) Disconnect Multimeter.

d. DELAYED OUTPUT LEVEL ADJUSTMENT. - The delayed output level adjustment and test points are shown in figures 5-9, 5-27 and 5-32.

(1) TEST EQUIPMENT. Multimeter, AN/USM-183.

(2) INSTRUCTIONS.

(a) Set delayed TIME/CM to .1 MSEC.

(b) Set SWEEP MODE to SINGLE.

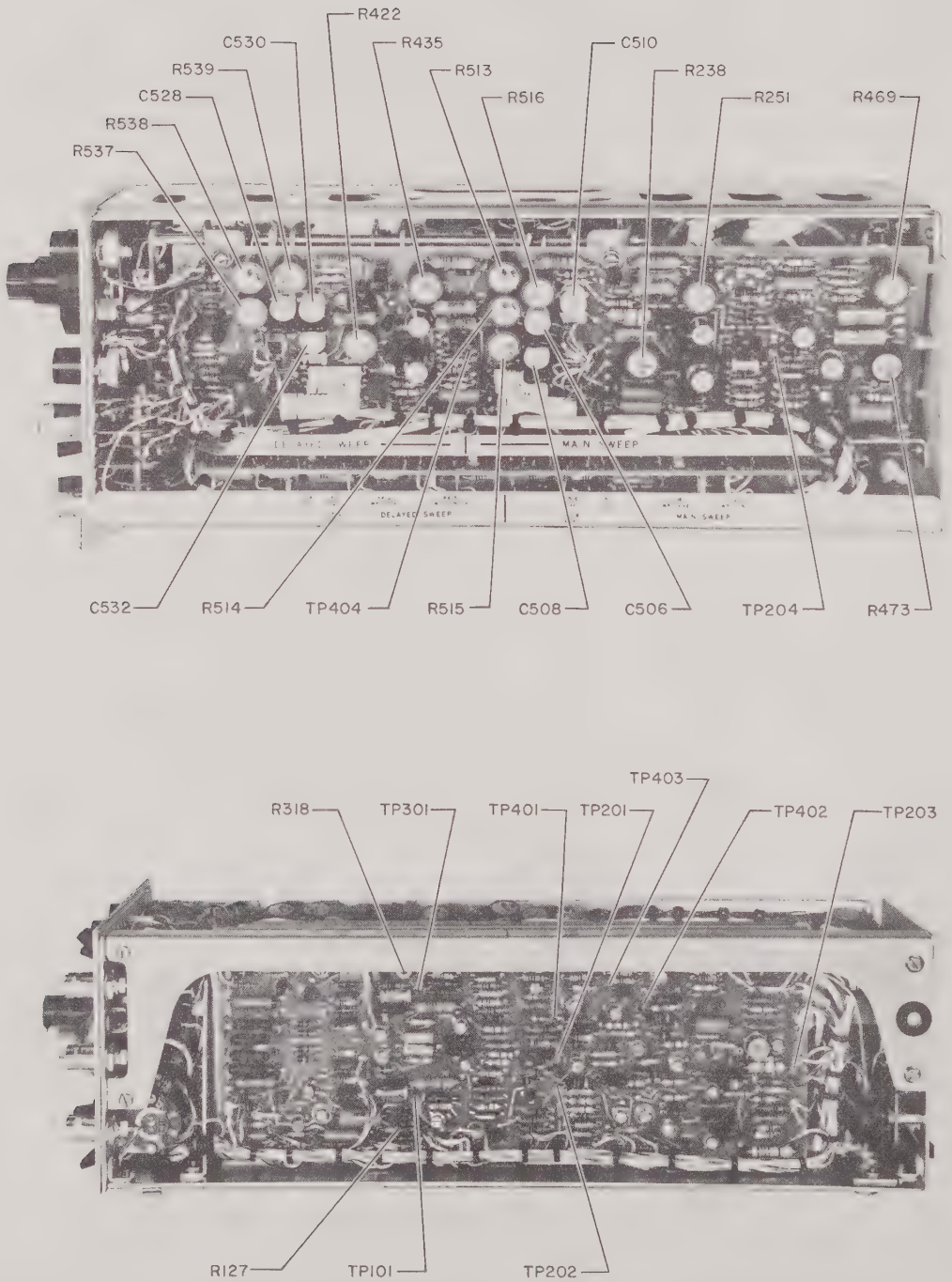


Figure 5-9. Time Base and Delay Generator Adjustments and Test Points

(c) Set Multimeter to read low dc voltage and connect Multimeter to TP404.

(d) Adjust R422 to obtain a reading of 0 vdc.

(e) Disconnect Multimeter.

e. MAIN SWEEP LENGTH ADJUSTMENT. - The main sweep length adjustment is shown in figures 5-9, 5-27 and 5-32.

(1) TEST EQUIPMENT. Oscillator, 0-1025/U.

(2) INSTRUCTIONS.

(a) Connect Oscillator output to channel A INPUT and adjust Oscillator to provide a 100 kHz, 3 v peak-to-peak output signal.

(b) Adjust main TRIGGER LEVEL to provide shortest horizontal display.

(c) Adjust R251 for a horizontal display of 10 cm.

(d) Using HORIZONTAL POSITION, place right edge of display on ninth graticule line.

(e) Readjust R251 to increase display length 0.2 cm (right edge of waveform on 9.2 cm graticule).

NOTE

Total display length is now 10.2 cm.

(f) Disconnect Oscillator.

f. DELAYED SWEEP LENGTH ADJUSTMENT. - The delayed sweep length adjustment is shown in figures 5-9, 5-27 and 5-32.

(1) TEST EQUIPMENT. Oscillator, 0-1025/U.

(2) INSTRUCTIONS.

(a) Connect Oscillator output to channel A INPUT and adjust Oscillator to provide a 100 kHz, 3 v peak-to-peak output signal.

(b) Set sweep display to DELAYED and delayed TIME/CM to .5 MSEC.

(c) Adjust delayed TRIGGER LEVEL for the shortest horizontal display.

(d) Adjust R435 for a horizontal display of 10 cm.

(e) Using HORIZONTAL POSITION, place right edge of display on eighth graticule line.

(f) Readjust R435 to increase display length 1.5 cm (right edge of waveform on 9.5 cm graticule).

NOTE

Total display length is now 11.5 cm.

g. MAIN SWEEP TIME ADJUSTMENT. - The main sweep time adjustments are shown in figures 5-9, 5-27 and 5-32.

(1) TEST EQUIPMENT. Time Mark Generator, Type 180.

(2) INSTRUCTIONS.

(a) Set SWEEP MODE to NORM.

(b) Connect Time Mark Generator output to channel A INPUT.

(c) Set Time Mark Generator and main TIME/CM to each of the settings listed table 5-9. At each setting adjust main TRIGGER LEVEL for stable display and HORIZONTAL POSITION to align first marker with left edge of graticule. Then make appropriate adjustment specified in table 5-9 to align eleventh marker with right edge of graticule.

TABLE 5-9. MAIN SWEEP TIME ADJUSTMENTS

TIME MARK GENERATOR SETTING	MAIN TIME/CM SETTING	ADJUST
10 MHz	.1 USEC	C510
1 usec	1 USEC	C508
5 usec	5 USEC	C506
50 usec	50 USEC	R516
500 used	.5 MSEC	R515
5 msec	5 MSEC	R514
50 msec	50 MSEC	R513

(d) Disconnect Time Mark Generator.

h. DELAYED SWEEP TIME ADJUSTMENT. - The delayed sweep time adjustments are shown in figures 5-9, 5-27 and 5-32.

(1) TEST EQUIPMENT. Time Mark Generator, Type 180.

(2) INSTRUCTIONS.

(a) Set SWEEP MODE to NORM, sweep display to DELAYED, and main TIME/CM to .2 USEC.

(b) Connect Time Mark Generator output to channel A INPUT.

(c) Set Time Mark Generator and delayed TIME/CM to each of the settings listed in table 5-10. At each setting adjust delayed TRIGGER LEVEL for stable display and HORIZONTAL POSITION to align first marker with left edge of graticule. Then make appropriate adjustment specified in table 5-10 to align eleventh marker with right edge of graticule.

(d) Disconnect Time Mark Generator.

TABLE 5-10. DELAYED SWEEP TIME ADJUSTMENTS

TIME MARK GENERATOR SETTING	DELAYED TIME/CM SETTING	ADJUST
10 MHz	.1 USEC	C532
1 usec	1 USEC	C530
5 usec	5 USEC	C528
50 usec	50 USEC	R539
500 usec	.5 MSEC	R538
5 msec	5 MSEC	R537

i. SWEEP COMPARATOR ADJUSTMENT. - The sweep comparator adjustments are shown in figures 5-9, 5-27 and 5-32.

(1) TEST EQUIPMENT. Time Mark Generator, Type 180.

(2) CONTROL SETTINGS. Reset following controls:

(a) Set main TIME/CM to 1 MSEC.
(b) Set delayed TIME/CM to 10 USEC.
(c) Set delayed trigger source to AUTO.
(d) Set CM DELAY to 0.
(e) Set SWEEP MODE to NORM.
(f) Set sweep display to DELAYED.

(3) INSTRUCTIONS.

(a) Connect Time Mark Generator output to channel A INPUT and set Time Mark Generator to provide 1 msec markers.

(b) Rotate CM DELAY cw until first marker appears, then set CM DELAY to 1.00 and adjust R473 to align leading edge of first marker with start of sweep.

(c) Rotate CM DELAY ccw to 0.

(d) Rotate CM DELAY cw until ninth marker appears, then set CM DELAY to 9.00 and adjust R469 to align leading edge of ninth marker with start of sweep.

(e) Disconnect Time Mark Generator.

j. TRIGGER SYMMETRY ADJUSTMENT. - The trigger symmetry adjustments are shown in figures 5-9, 5-26 and 5-32.

(1) TEST EQUIPMENT.

(a) Oscillator, 0-1025/U.
(b) Tee-Connector (2 required), UG-274B/U.

(2) CONTROL SETTINGS. - Reset following controls:

(a) Set main TIME/CM to 1 MSEC.
(b) Set SWEEP MODE to NORM.
(c) Set main trigger source to EXT ÷ 10.
(d) Set delayed trigger source to EXT ÷ 10.

(3) INSTRUCTIONS.

(a) Connect Oscillator output to channel A INPUT and to main and delayed EXT INPUT. (Use 2 Tee-Connectors.)

(b) Set Oscillator frequency to 1 kHz and adjust output to approximately 1.5 v peak-to-peak.

(c) Adjust main TRIGGER LEVEL for stable display.

(d) Adjust Oscillator output to obtain exactly 3 cm of vertical deflection (1.5 v peak-to-peak).

(e) Adjust A POSITION to center trace vertically.

(f) Set main TRIGGER LEVEL to 0.

(g) Adjust R127 for a stable presentation that starts at zero level on sine wave. Zero level is center horizontal graticule if trace was centered exactly.

(h) Switch main trigger SLOPE between + and -, and verify that trigger point does not move.

NOTE

If trigger point moves while switching between + and -, readjust R127 as required.

(i) Set delayed TIME/CM to .5 MSEC and sweep display to DELAYED.

(j) Set delayed TRIGGER LEVEL to 0 and adjust R318 for a stable presentation that starts at zero level (center horizontal graticule) on sine wave.

(k) Switch delayed trigger SLOPE between + and -, and verify that trigger point does not move.

NOTE

If trigger point moves while switching between + and -, readjust R318 as required.

(l) Disconnect Oscillator.

5-8. REPAIR AND REPLACEMENT.

Repair and replacement procedures for the AN/USM-281 Oscilloscope are contained in the following paragraphs. After completing repair or replacement, refer to table 5-2 and perform the applicable reference standards procedures to determine if the oscilloscope is functioning properly. If the reference standards procedures indicate that the repair has affected oscilloscope performance, perform the applicable adjustment procedure (paragraphs 5-5, 5-6, or 5-7) to restore the accuracy of the instrument.

a. HIGH VOLTAGE SUPPLY REPLACEMENT. - To replace the high voltage tripler assembly A1A8, the high voltage rectifier assembly A1A5, or the high voltage transformer A1T301 use the following procedure. See figures 5-10 and 5-17 for location of components.

(1) Set oscilloscope POWER switch off and

disconnect power cord.

(2) Remove oscilloscope left-hand cover per paragraph 5-5a.

(3) Remove two screws and remove high voltage assembly cover. See figure 5-10.

(4) Remove rear instrument cover.

(5) Unsolder five wires from small etched circuit board mounted to T301 and mark leads to aid in replacement.

(6) Remove four screws from corners of rectifier assembly A1A5 and two screws from ends of T301.

(7) Unsolder leads at cathode end of CR302 and CR307 (figure 5-17) and mark leads.

(8) Unsolder lead at junction of C309 and R325 and mark lead.

WARNING

The post accelerator lead may hold a high voltage charge. To remove this lead use a screwdriver with an insulated handle. Ground the screwdriver with a test lead and insert the end of the screwdriver under the insulator cap to discharge the high voltage lead.

(9) Remove post accelerator lead.

(10) Raise the rectifier assembly (including T301) from compartment in the high voltage supply box.

NOTE

T301 should be completely disconnected. Small board is part of transformer.

(11) Complete disassembly by unsoldering remaining leads from the rectifier circuit board and identifying leads.

(12) Insert replacement assembly in high voltage supply box and resolder leads disconnected in steps 7, 8, and 11. Use rosin-core solder type 63-37 (preferred) or 60-40 with a maximum diameter of 1/16 inch to Specification QQ-S-571 with Flux to MIL-F-14526.

(13) Install two screws in ends of T301 and four screws in corners of rectifier assembly A1A5.

(14) Reconnect post accelerator lead.

(15) Resolder five wires to small etched circuit board mounted to T301.

(16) Replace rear instrument cover.

(17) Replace high voltage assembly cover.

(18) Replace oscilloscope left-hand cover.

(19) Perform high voltage power supply adjustment procedures, paragraph 5-5c.

b. CRT REPLACEMENT. - Perform the following procedure to replace the CRT. See figure 5-10 for location of components.

(1) Set oscilloscope POWER switch off and disconnect power cord.

(2) Remove plug-in units per paragraph 2-5a.

(3) Remove both oscilloscope covers per paragraph 5-5a.

WARNING

The CRT is a high-vacuum tube and any severe shock or stress could cause the tube to implode. To prevent personal injury wear a face mask or goggles and gloves. Exercise extreme care when handling the CRT.

(4) Remove the nine neck pins from the CRT. Use long-nose pliers through access holes for pins on top of neck.

WARNING

The post accelerator lead may hold a high voltage charge. To remove this lead use a screwdriver with an insulated handle. Ground the screwdriver with a test lead and insert the tip of the screwdriver under the insulator cap to discharge the high voltage lead.

(5) Remove post accelerator lead from CRT.

(6) Squeeze the plastic light shield at middle of top and bottom, and remove light shield.

(7) Remove screws holding metal bezel on front panel. Remove bezel and gasket.

(8) Carefully pry the CRT socket from the CRT base.

(9) Loosen CRT clamp at rear of tube.

(10) Place one hand on the CRT face and, with the other hand, slide the CRT forward and out of the instrument.

(11) Insert new CRT into the instrument and slide tube all the way in.

(12) Replace gasket and metal bezel. Tighten screws.

(13) Replace plastic light shield.

WARNING

Do not overtighten CRT clamp.

(14) Tighten CRT clamp. Clamp should be tight enough to prevent the CRT from moving.

(15) Press CRT socket onto the CRT base.

(16) Reconnect post accelerator lead.

(17) Reconnect nine neck pins.

(18) Replace oscilloscope covers and install plug-in units.

(19) Check the following adjustments:

(a) Intensity limit. (Refer to paragraph 5-5e.)

(b) Flood gun. (Refer to paragraph 5-5f.)

(c) Trace alignment. (Refer to paragraph 5-5g.)

(d) Horizontal amplifier gain. (Refer to paragraph 5-5k.)

c. ETCHED CIRCUIT BOARD COMPONENT REPLACEMENT. - Most of the electrical components in the AN/USM-281 Oscilloscope are mounted on etched circuit boards and are accessible by removing the plug-in units and/or the oscilloscope covers. All

of the etched circuit boards in the oscilloscope are factory coated with a moistureproof sealant to allow the instrument to function in a high humidity environment. After completing a repair on a circuit board, the affected area must be recoated with a moisture proofing compound such as General Electric Dri-Film 88 (DF-88) to preserve the integrity of the instrument. To replace a component on an etched circuit board proceed in accordance with the following general instructions:

(1) Set oscilloscope POWER switch off and disconnect power cord.

(2) Use parts location diagrams, figures 5-10 through 5-27, to locate defective component.

(3) Remove plug-in units (paragraph 2-5a) and/or oscilloscope covers (paragraph 5-5a) as required.

(4) If a component is known to be faulty, cut the leads close to the component.

CAUTION

When soldering (or unsoldering) circuit board components, use a low heat (37 to 47.5 watts, less than 800°F idling temperature) slightly bent chisel type (1/16 to 1/8 inch diameter) soldering iron. Apply heat sparingly to prevent damage to the board or component. When soldering a semiconductor or other heat-sensitive component, grip the component lead between the component and the circuit board with a pair of long-nosed pliers or other suitable heat sink.

(5) Place the soldering iron on the component lead and pull the lead from the board.

NOTE

Large components such as potentiometers may be removed by rotating the soldering iron from lead to lead and applying steady pressure to lift the part free.

(6) Clean solder from the lead holes with a toothpick and soldering iron.

(7) Shape the leads of the replacement part and insert the leads into the circuit board holes.

NOTE

If space is limited, cut component leads to size (leads should extend approximately 1/16 of an inch beyond the board) before inserting component in board and disregard steps 8 and 10.

(8) Press the component against the circuit board and bend the leads (on the back side of the board) outward (approximately 45°) to hold the component in place.

(9) Attach heat sink (if required) to component lead and place soldering iron on the junction of the component lead and circuit board foil (preferrably on the back side of the board) and apply solder. Use a rosin-core solder type 63-37 (preferred) or 60-40 with a maximum diameter of 1/16 inch to Specification QQ-S-571 with flux to MIL-F-14526.

(10) If leads were not previously cut to length, cut component leads as close to the circuit board as possible.

(11) Clean rosin from circuit board with isopropyl alcohol to Specification TT-I-735.

(12) Recoat serviced area with moisture proofing compound such as General Electric DF-88 (or equivalent).

d. ETCHED CIRCUIT BOARD REPAIR. - The conductor portion of the etched circuit boards is a metal plated surface covered with solder. If a circuit board is overheated while replacing a component, the conductor may lift away from the board. A lifted conductor can be repaired by applying (use sparingly) a quick-drying acetate base cement having good insulating properties to the conductor, and reattaching the conductor to the board. If cement is not available or if a conductor is damaged, repair the circuit board by soldering a section of copper wire along the damaged conductor to complete the circuit.

e. MISCELLANEOUS COMPONENT REPLACEMENT. - To replace components not covered by the previous replacement procedures, observe the following general rules and precautions:

(1) Always set oscilloscope POWER switch off and disconnect power cord.

(2) Locate component to be replaced on location diagrams (figures 5-10 through 5-12).

(3) Remove oscilloscope covers (paragraph 5-5a) and/or plug-in units (paragraph 2-5a) as required to gain access to component.

(4) Attach masking tape to leads (if required) and mark leads to aid in identifying the leads for reconnection.

(5) Unsolder leads.

(6) Use location diagrams (figures 5-10 through 5-12) to determine how component is attached and remove component.

(7) Install new component, reconnect and solder leads.

(8) Clean rosin from solder joints with isopropyl alcohol to Specification TT-I-735.

(9) Replace oscilloscope covers and/or plug-in units.

(10) Determine which functional section of the instrument was affected by repair (from schematic diagrams figures 5-30 through 5-32), then refer to table 5-2 to locate the reference standards procedure for the affected section.

(11) Perform applicable reference standards procedure and, if required to meet performance standards, perform the necessary adjustment(s) in accordance with paragraphs 5-5, 5-6 or 5-7.

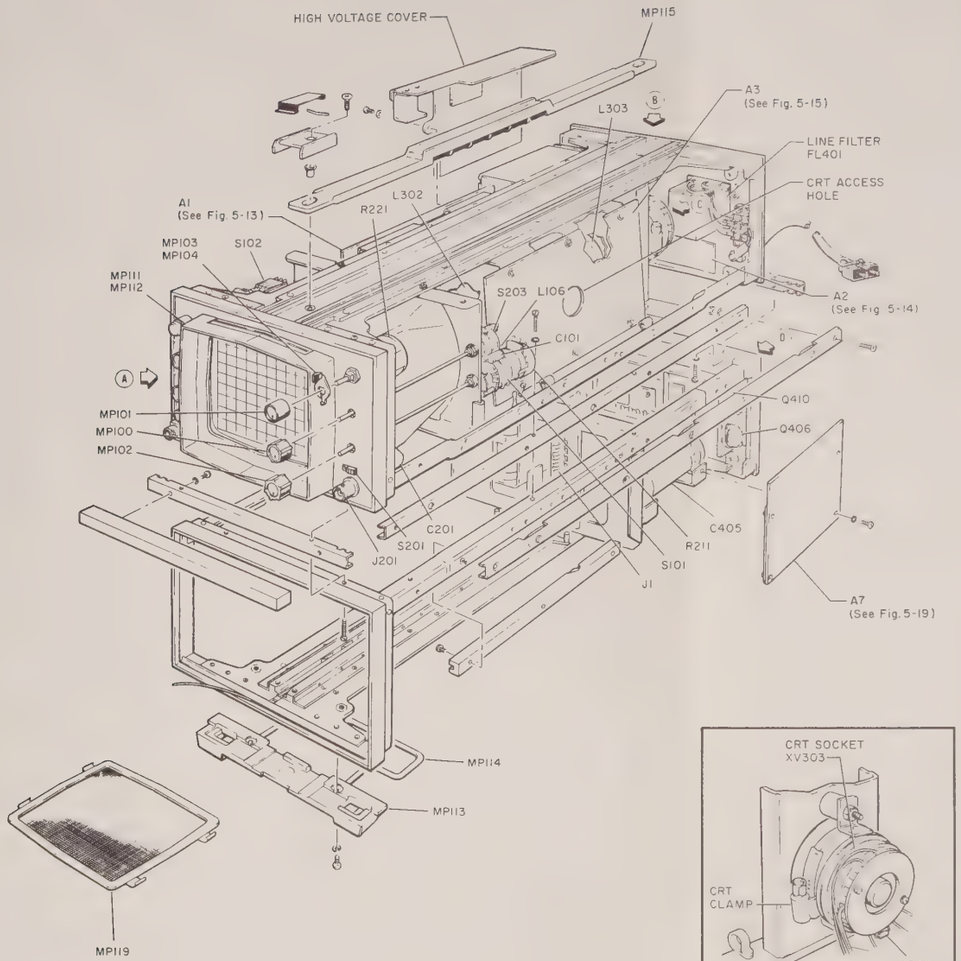
5-9. LOCATION OF PARTS.

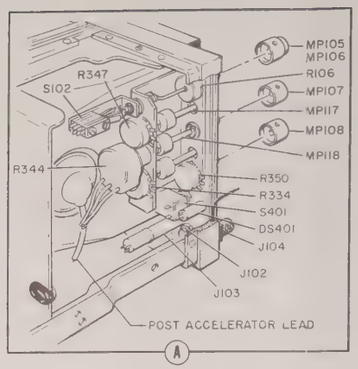
Figures 5-10 through 5-28 show location of parts. Parts and subassemblies are identified on the illustrations by reference designations and are cross-referenced in tables adjacent to the illustrations when the number of parts exceeds 30. These tables locate parts by the use of map-type coordinates. The parts list, table 6-1, also lists all parts by reference designations and cross-references the illustration where the part appears. Figures 5-29 through 5-32 provide the oscilloscope schematic diagrams. The schematic diagrams also identify parts and sub-

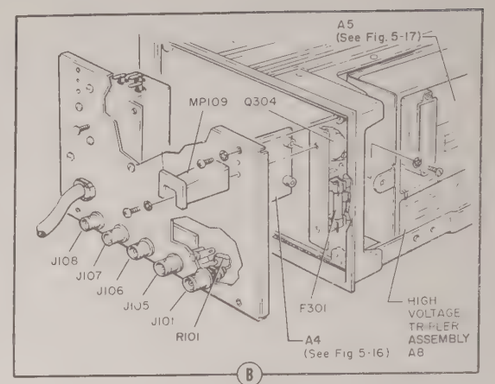
assemblies by reference designations and provide a parts location table (adjacent to the schematic) when the number of parts exceeds 50. Table 5-11 lists the major subassemblies by reference designation and references the parts location and schematic diagrams where these subassemblies appear.

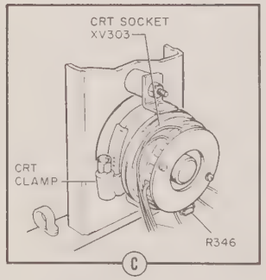
TABLE 5-11. SUBASSEMBLY CROSS-REFERENCE INDEX

SUBASSEMBLY REFERENCE DESIGNATOR	PARTS LOCATION DIAGRAM FIGURE NUMBER	SCHEMATIC DIAGRAM FIGURE NUMBER
A1A1	5-13	5-30
A1A2	5-14	5-30
A1A3	5-15	5-30
A1A4	5-16	5-30
A1A5	5-17	5-30
A1A6	5-18	5-30
A1A7	5-19	5-30
A1A8	5-10	5-30
A2A1	5-20	5-31
A2A2	5-21	5-31
A2A3	5-22	5-31
A2A4	5-23	5-31
A2A5	5-24	5-31
A2A6	5-25	5-31
A3A1	5-26	5-32
A3A2	5-27	5-32
A3A3	5-28	5-32









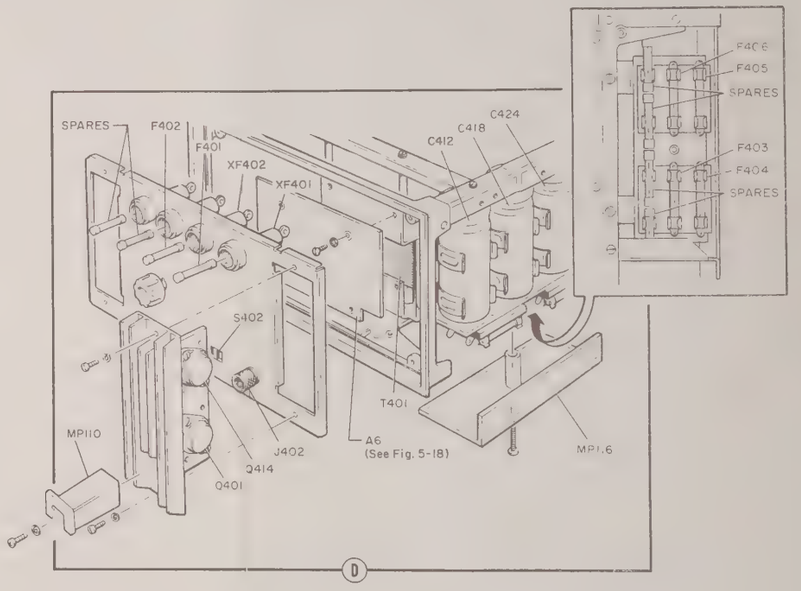


Figure 5-10. Oscilloscopy Assembly A1, Location of Parts

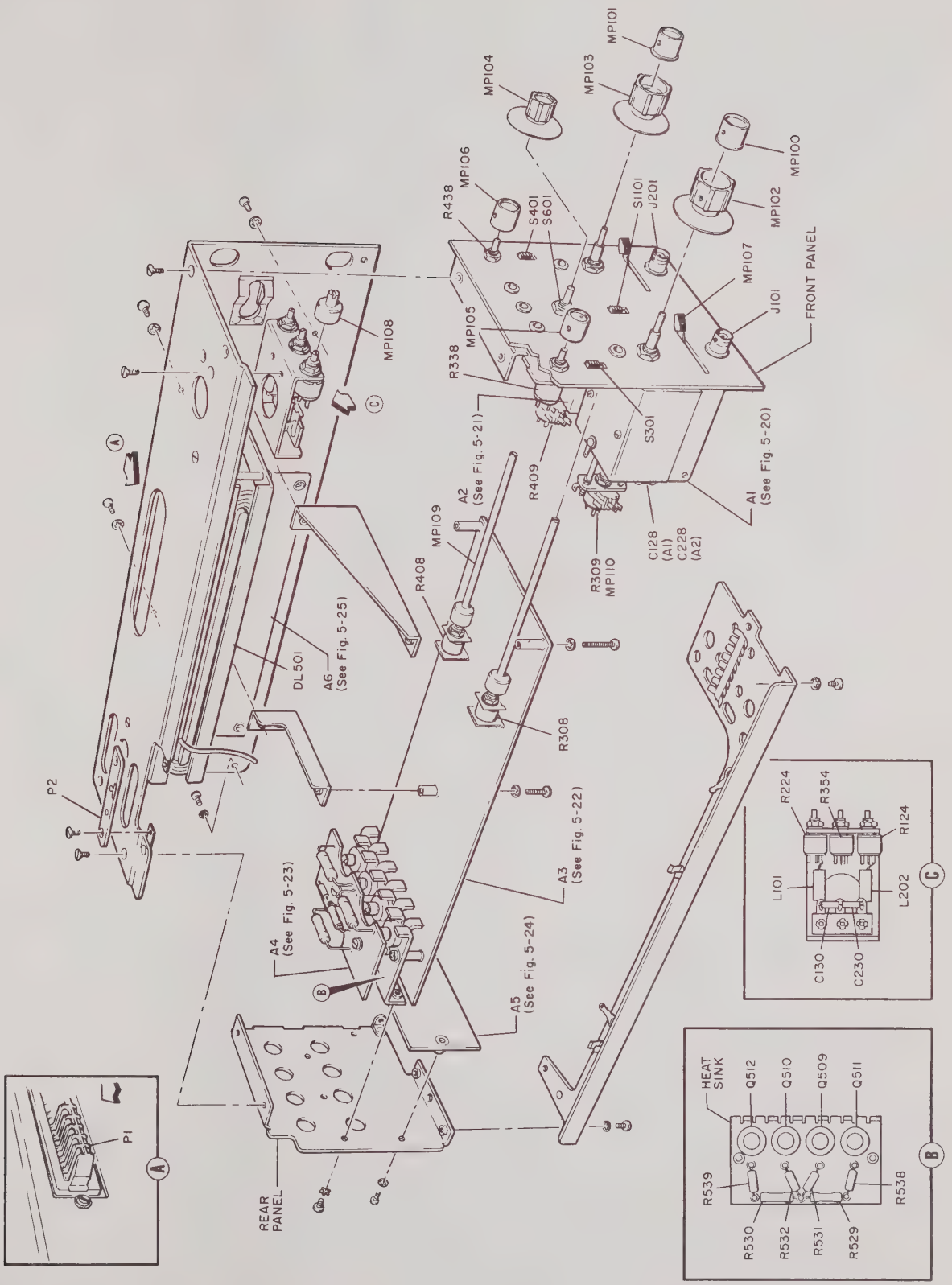


Figure 5-11. Dual Channel Vertical Amplifier A2, Location of Parts

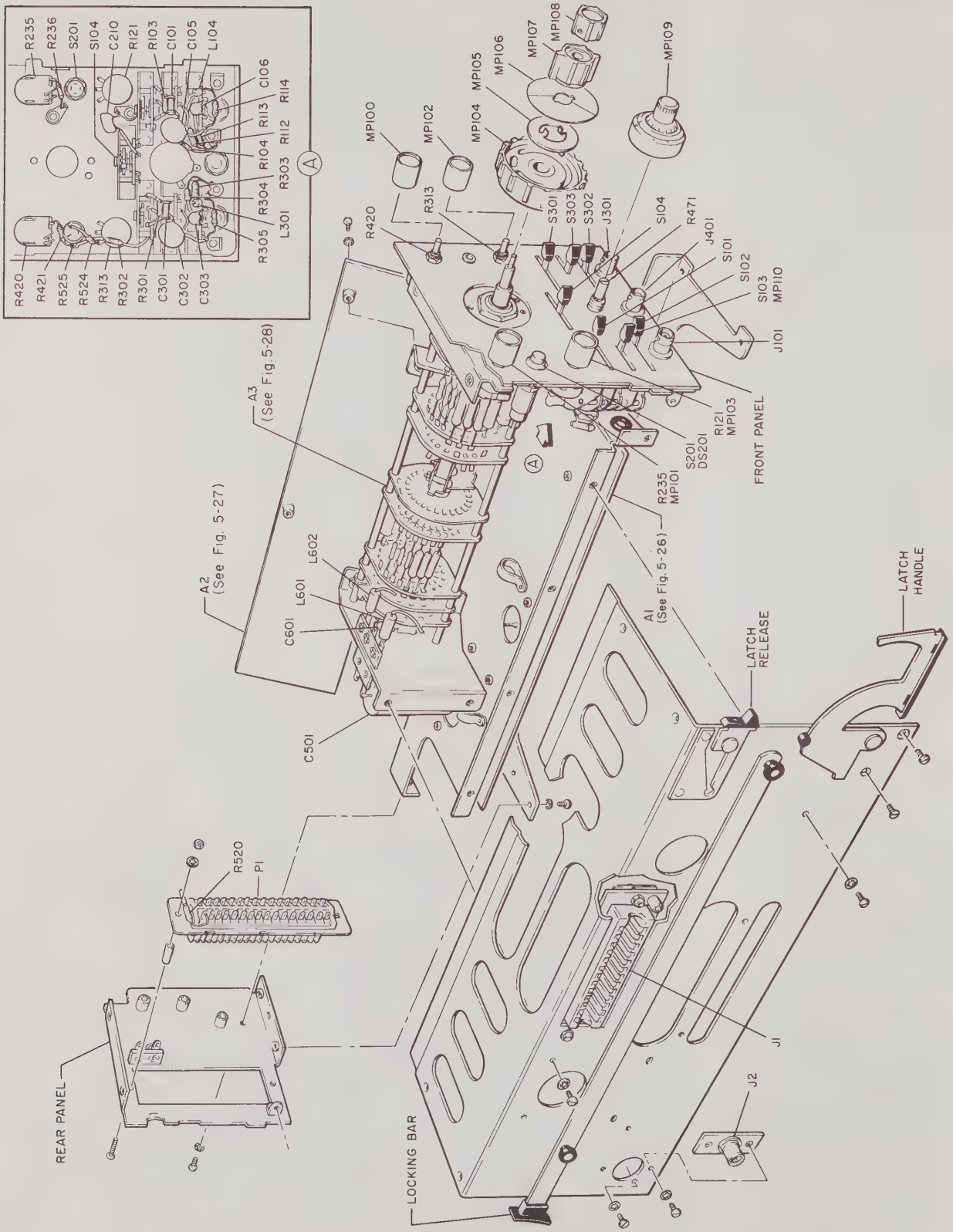


Figure 5-12. Time Base and Delay Generator A3, Location of Parts

PARTS LOCATION INDEX

REF. DESIG.	DRAWING LOCATION
C102	8E
C103	8E
C104	7E
C105	8D
C106	7F
C110	7D
C111	6C
C112	7D
C113	6C
C114	6D
C115	6E
C116	7C
C120	6B
C121	7B
C122	7B
C123	4B
C301	4F
C302	3C
C303	4C
C310	3B
C311	3B
C316	3C
C317	3C
CR101	7E
CR102	7E
CR103	7F
CR104	7F
CR108	7E
CR109	6E

REF. DESIG.	DRAWING LOCATION
CR110	6D
CR111	8C
CR112	4C
CR113	4C
CR115	7B
CR116	6C
CR117	6C
L102	6F
L105	5C
Q101	8F
Q102	7D
Q103	6D
Q104	6D
Q105	8C
Q106	6B
Q107	7B
Q301	3D
Q302	4E
Q303	4E
R102	8D
R103	8D
R104	8E
R105	8E
R107	8E
R111	6E
R112	8C
R113	6F
R114	7E
R115	7D

REF. DESIG.	DRAWING LOCATION
R116	7E
R117	8D
R118	7D
R119	7C
R120	6C
R121	6C
R125	7E
R126	7E
R127	6E
R128	7C
R129	8C
R130	8C
R131	8C
R132	8C
R133	4C
R136	7C
R137	7B
R138	7B
R139	6B
R140	6B
R141	6B
R142	7B
R143	8B
R144	8B
R145	8B
R301	5E
R302	3E
R303	3F
R304	3D

REF. DESIG.	DRAWING LOCATION
R305	2D-2E
R313	3E
R314	3E
R315	4D
R316	3D
R317	4E
R318	4E
R319	4E
R320	4D
R321	4D
R328	2B
R330	5D
R331	5D
R332	5D
R333	5C
R341	2C
R343	1C
R345	1E
R348	5C
R349	5C
R351	5D
R352	5D
R353	5D
R354	5E
TP301	2C
V301	2B
V302	2C
VR301	4D
VR302	4D

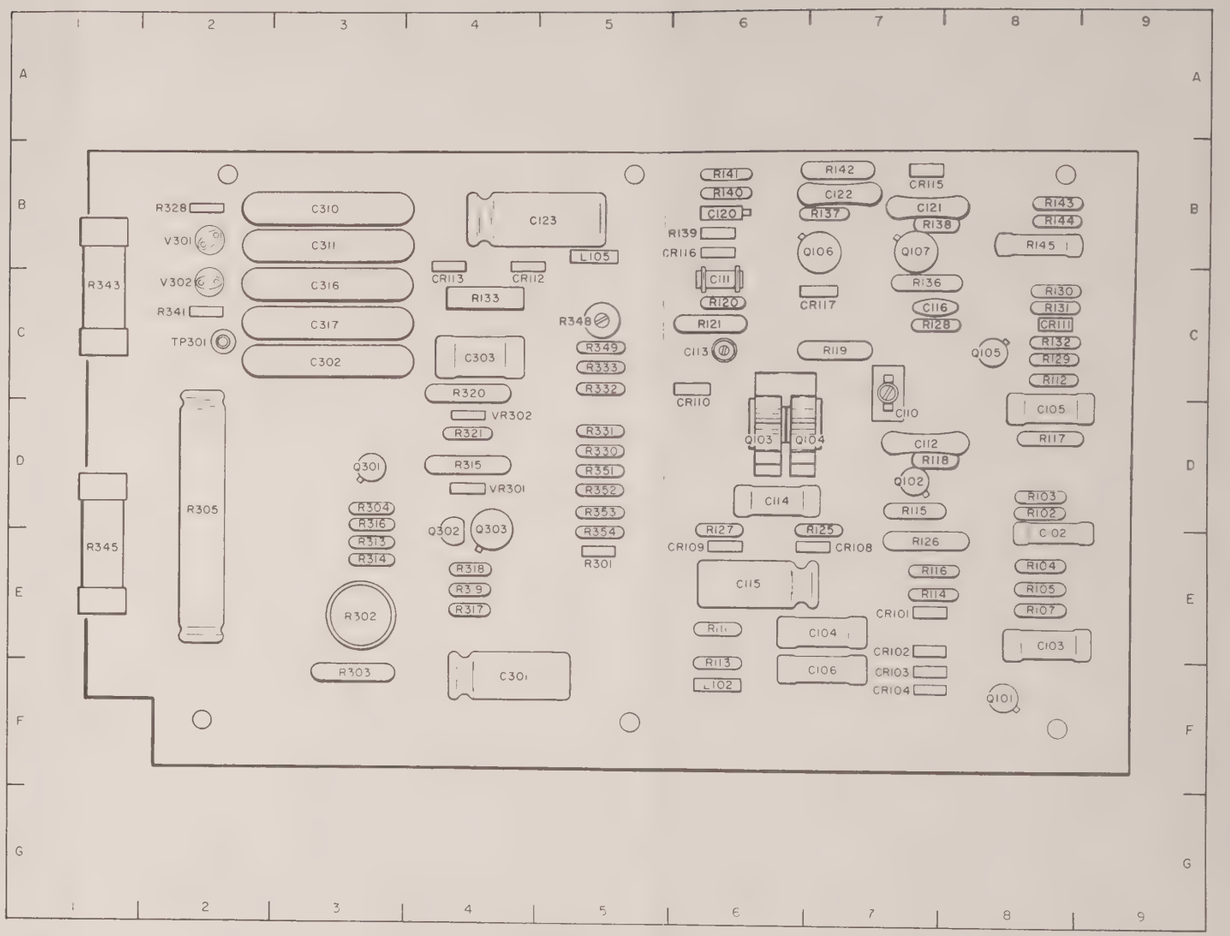


Figure 5-13. Calibrator, Gate, and High Voltage Control Circuit Board A1A1, Location of Parts

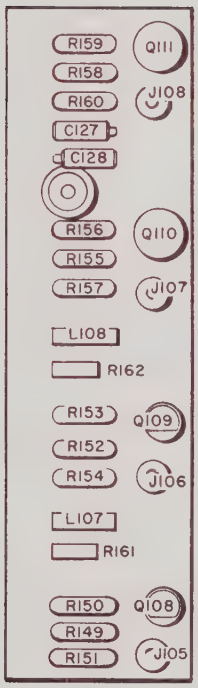


Figure 5-14. Main and Delayed Sweep and Main and Delayed Gate Output Amplifiers Circuit Board A1A2, Location of Parts

PARTS LOCATION INDEX FOR FIGURE 5-15

REF. DESIG.	DRAWING LOCATION
C202	2C
C203	1D
C204	1D
C205	2F
C206	2E
C210	5E
C211	7F
C212	8E
C213	6D
C214	5D
C218	8D
C219	2B
C220	4F
C221	4E
C222	8D
C226	4B
C227	8C
C228	7B
C229	5C
C230	7C
C231	8C
CR201	2C
CR202	4E
CR203	4E
CR204	4E
CR205	8D

REF. DESIG.	DRAWING LOCATION
CR206	4C
CR207	4C
CR208	6B
CR209	8C
L200	8D
L201	2B
L202	4F
L203	3F
Q201	2C
Q202	2C
Q203	3F
Q204	3F
Q205	3C
Q206	4D
Q207	4C
Q208	5F
Q209	6E
Q210	7E
Q211	6C
Q212	6C
Q213	7C
R201	2C
R202	2C
R203	2C
R204	2D
R205	2D

REF. DESIG.	DRAWING LOCATION
R206	2D
R207	3E
R208	2D
R209	2D
R210	2D
R215	3E
R216	2E
R217	2E
R219	2E
R220	2E
R222	4E
R223	4E
R225	4D
R229	4E
R230	4E
R231	5E
R232	7F
R234	7D
R235	8E
R237	8E
R238	7E
R239	6D
R244	4E
R245	8D
R246	3B

REF. DESIG.	DRAWING LOCATION
R247	4C
R248	3C
R249	4D
R250	3D
R251	4D
R252	4D
R253	4B
R254	4C
R257	4B
R258	4B
R259	4C
R261	4C
R262	7C
R263	7B
R264	6C
R268	6C
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R336	7B
R337	8B
S202	1B

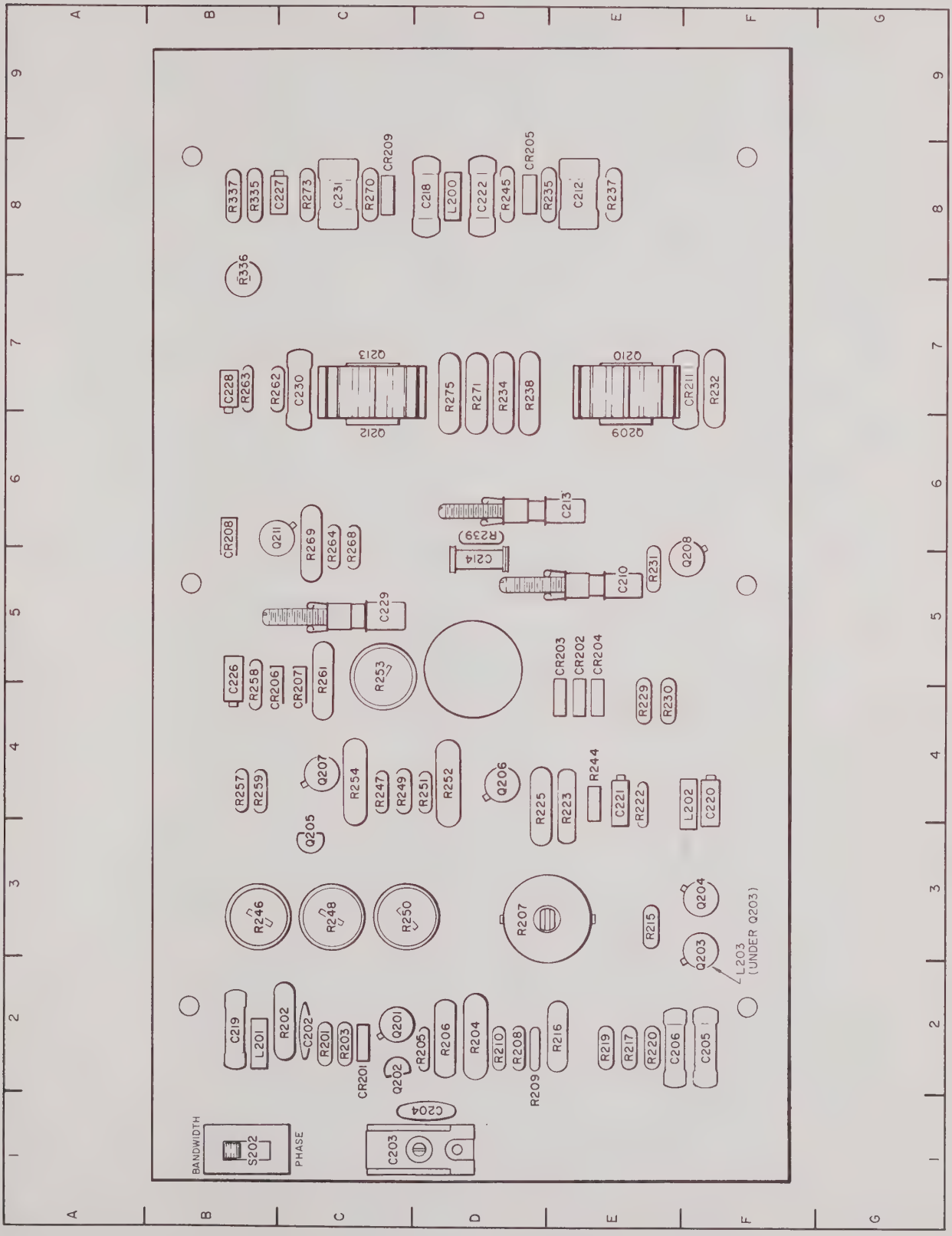


Figure 5-15. Horizontal Amplifier Circuit Board A1A3, Location of Parts

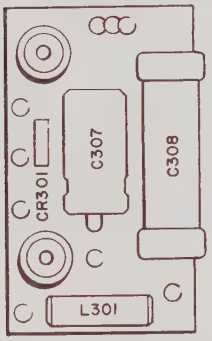


Figure 5-16. High Voltage Oscillator Circuit Board A1A4, Location of Parts

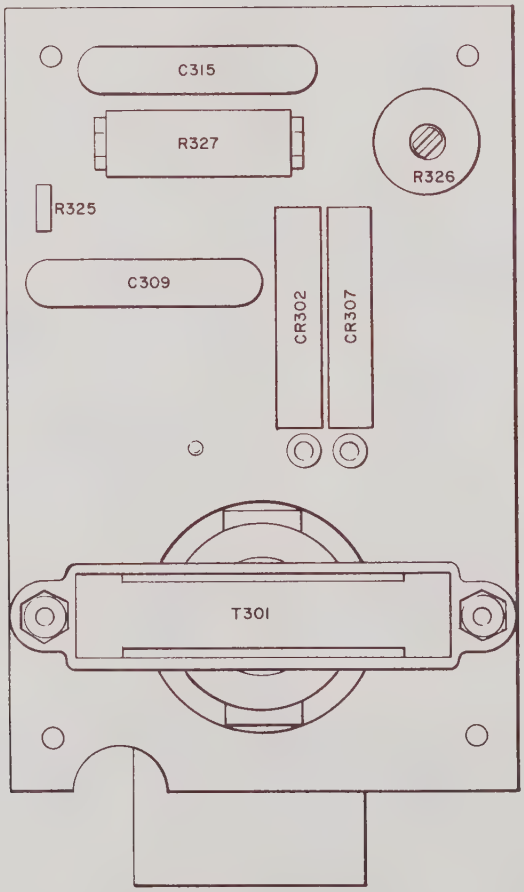


Figure 5-17. High Voltage Rectifier Circuit Board A1A2, Location of Parts

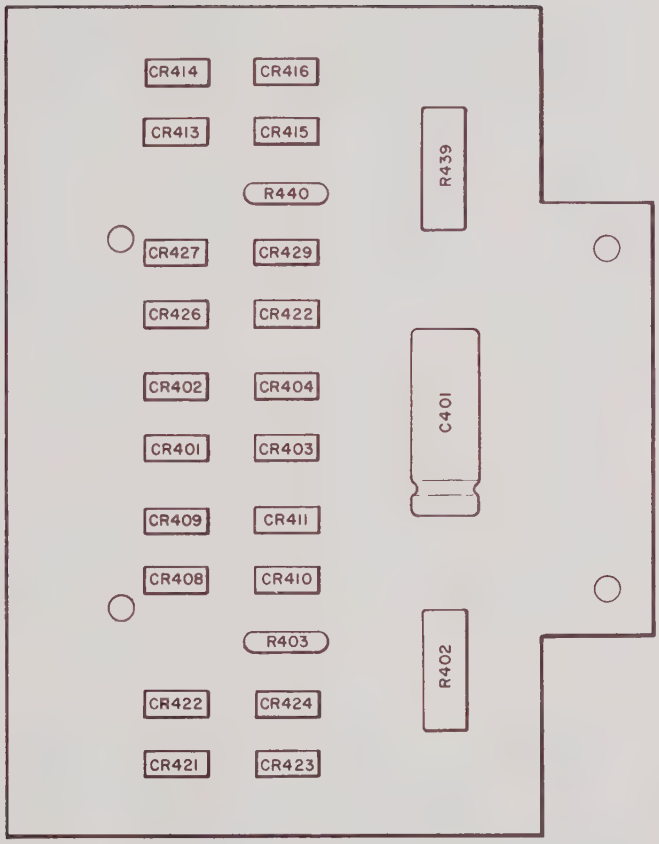
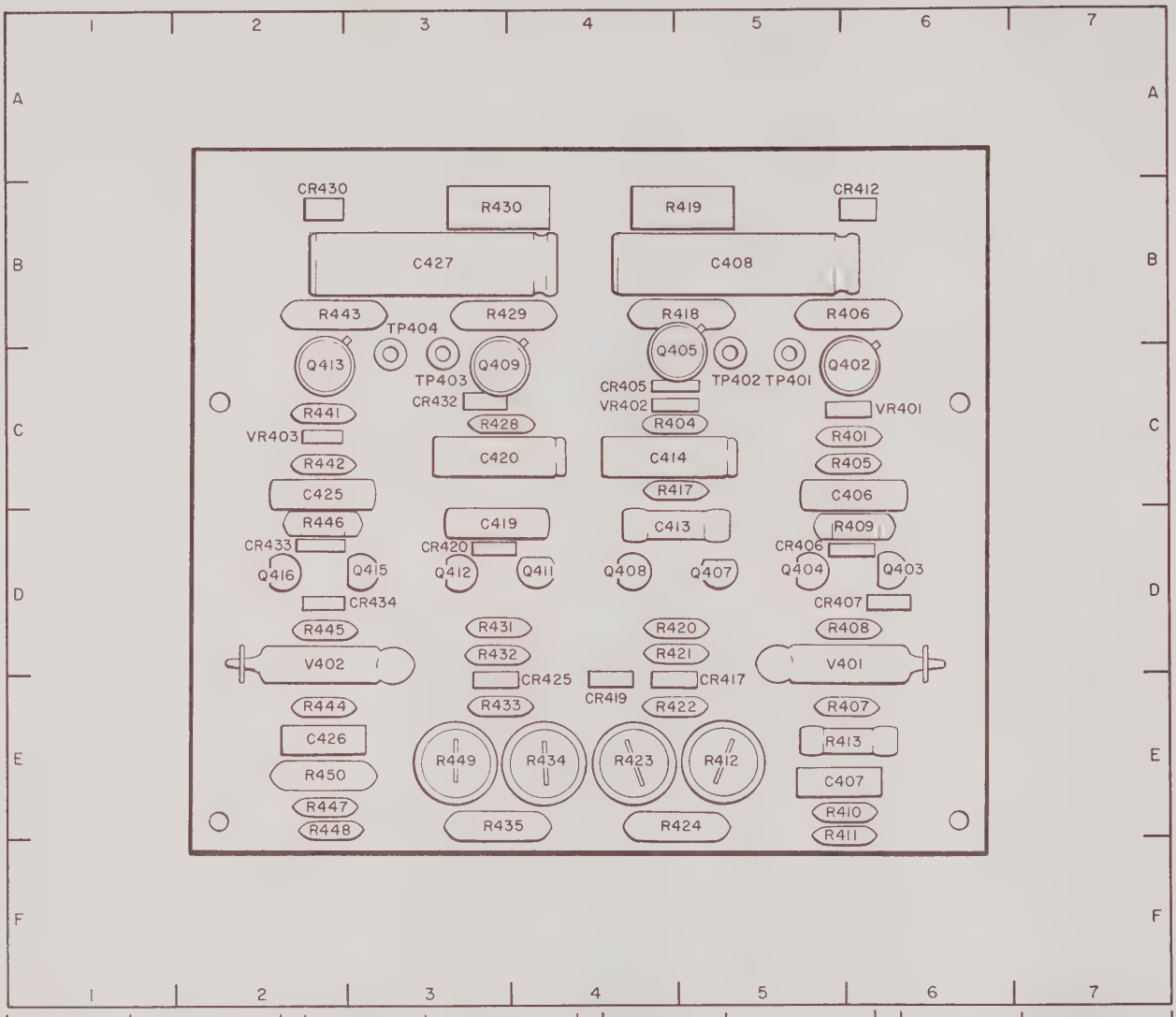


Figure 5-18. Low Voltage Rectifier Circuit Board A1A6, Location of Parts



REF. DESIG.	DRAWING LOCATION	REF. DESIG.	DRAWING LOCATION	REF. DESIG.	DRAWING LOCATION	REF. DESIG.	DRAWING LOCATION
C406	6C	CR433	2D	R409	6D	R435	4E
C407	5E	CR434	2D	R410	6E	R441	3C
C408	5B	Q402	6C	R411	6E	R442	3C
C413	5D	Q403	6D	R412	5E	R443	3C
C414	5C	Q404	5D	R413	6E	R444	3E
C419	4D	Q405	5C	R417	5C	R445	3D
C420	4C	Q407	5D	R418	5B	R446	3C
C425	3C	Q408	4D	R419	5B	R447	3E
C426	3E	Q409	4C	R420	5D	R448	3E
C427	3B	Q411	4D	R421	5D	R449	3E
CR405	5C	Q412	3D	R422	5E	R450	3E
CR406	6D	Q413	3C	R423	4E	TP401	5C
CR407	6D	Q415	3D	R424	5E	TP402	5C
CR412	3B	Q416	2D	R428	4C	TP403	3C
CR417	5E	R401	6C	R429	4B	TP404	3C
CR419	4E	R404	5C	R430	3B	V401	5D
CR420	3D	R405	6C	R431	4D	V402	2D
CR425	4E	R406	6B	R432	4D	VR401	6C
CR430	3B	R407	6E	R433	4E	VR402	5C
CR432	3C	R408	6D	R434	4E	VR403	3C

Figure 5-19. Low Voltage Power Supply Circuit Board A1A7, Location of Parts

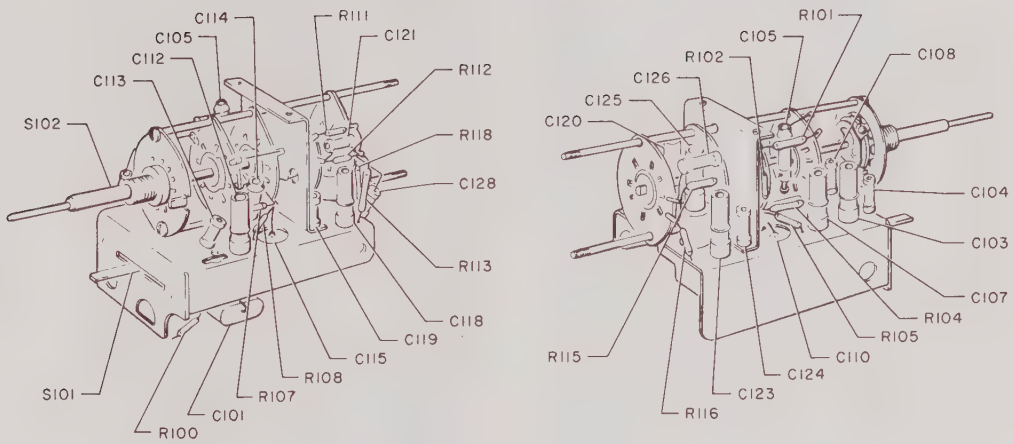


Figure 5-20. Channel A Attenuator Assembly A2A1, Location of Parts

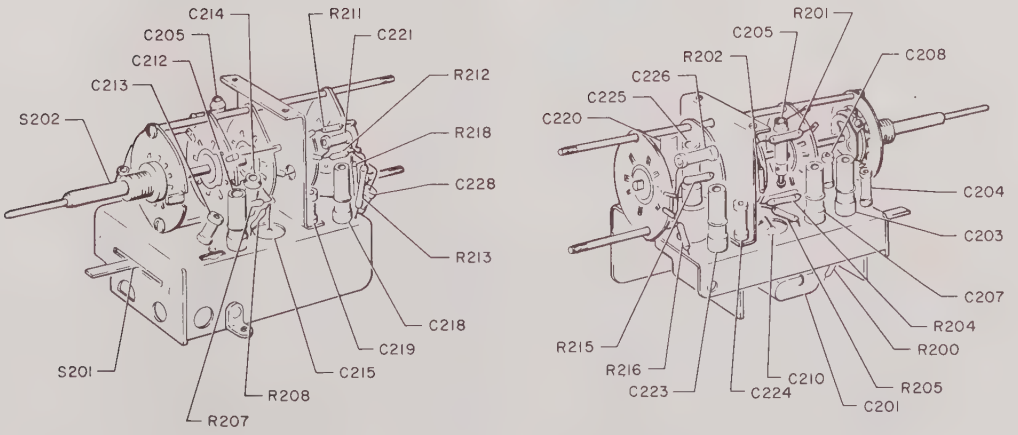


Figure 5-21. Channel B Attenuator Assembly A2A2, Location of Parts

PARTS LOCATION INDEX FOR FIGURE 5-22

REF. DESIG.	DRAWING LOCATION
C129	2C
C229	2A
C301	4D
C305	5C
C306	5D
C307	5C
C308	5C
C309	5D
C311	6C
C312	6D
C313	2H
C314	2I
C315	2H
C316	2H
C317	2H
C401	4B
C405	5A
C406	5B
C407	5B
C408	5A
C409	5B
C411	6A
C412	6B
C413	2F
C414	2G
C415	2F
C416	2F
C417	2F
C501	4G
C502	4G
C503	4H
C505	3G
C506	5H
C507	5G
C508	5G
C509	6G
C510	6G
C512	6I
C516	3D
C517	3D
C518	5H
C519	3G
C520	3G
C521	4F
C523	4F
C524	3G
C528	3C
C529	3B
C533	3H
C534	3C
C535	3G
C536	3B
C1101	6G
C1102	6F
CR101	3C
CR102	3C
CR201	3A
CR202	3A
CR302	5C
CR303	5D
CR304	6C
CR305	6D
CR306	5C
CR307	5D
CR308	6C
CR309	6D
CR313	3H
CR314	3I
CR315	3H
CR316	3I
CR402	5A
CR403	5B
CR404	6A
CR405	6B
CR406	5A
CR407	5B
CR408	6A
CR409	6B
CR413	3F
CR414	3F
CR415	3F
CR416	3G
CR501	6G
CR502	6G
CR1101	5F
K1101	6F
L301	4D
L402	5A
L403	5B
L503	5F
L504	5H
L506	6H
L510	5D
L511	3H
L512	3F
L513	3F
L514	5B
L518	3H
L519	3F
L520	3F
Q101	3C
Q102	3D
Q103	3C
Q104	3C
Q201	3B
Q202	3B
Q203	3B
Q204	3B
Q301	4C
Q302	4D
Q303	5C
Q304	5D
Q305	5C
Q306	5D
Q307	2I
Q308	2H
Q401	4B
Q402	4B
Q403	5A
Q404	5B
Q405	5A
Q406	5B
Q407	2F
Q408	2G
Q501	3G
Q502	3H
Q503	4G
Q504	4H
Q505	4F
Q506	4H
Q507	5F
Q508	5H
Q701	4H
Q702	4I
Q703	4H
Q704	4I
R119	2C
R120	3C
R121	3D
R122	3C
R123	3D
R125	4C
R126	3C
R127	3C
R219	2A
R220	3B
R221	3B
R222	3A
R223	3B
R225	4A
R226	3A
R227	3A
R301	4C
R302	4C
R303	4D
R304	4D
R305	3C
R306	3D
R307	4C
R309	4D Under Board
R310	4C
R311	3D
R315	3D
R316	3D
R317	4D
R318	5C
R319	5D
R320	5D
R324	5C
R325	5D
R326	5D
R327	6C
R328	6D
R329	5C
R330	5D
R332	6C
R333	6D
R334	6D
R335	6D
R336	2H
R337	2I
R342	2G
R343	2I
R344	2H
R345	2H
R346	2I
R347	2H
R348	2H
R351	3H
R352	3F
R353	3F
R401	4A
R402	4B
R403	4C
R404	4B
R405	3A
R406	3B
R407	4A
R409	4B Under Board
R410	4B
R411	3B
R415	3B
R416	3B
R417	4C
R418	5A
R419	5B
R420	5B
R424	5B
R425	5B
R426	5B
R427	6B
R428	6B
R429	5A
R430	5B
R432	6B
R433	6C
R434	6A
R435	6B
R436	2F
R437	2G
R442	2F
R443	2G
R444	2F
R445	2G
R446	2F
R447	2F
R448	2F
R501	4G
R502	4G
R503	3F
R504	3G
R508	4F
R509	3F
R510	3H
R511	3F
R512	3H
R516	4F
R517	4H
R518	4G
R519	4G
R520	4G
R521	4G
R522	4G
R526	4F
R527	4H
R528	6H
R533	5G
R534	5G
R540	6F
R541	5I
R542	6I
R549	3D
R550	3D
R551	3F
R554	3C
R555	3B
R701	3H
R702	3I
R703	3H
R704	3I
R705	3I
R706	3I
R707	3I
R708	5I
R709	5I
R710	5H
R711	5I
R712	5I
R1101	6G
R1102	6G
S1102	6F
T301	5D
T401	5B
VR301	5D
VR401	5C
VR501	6H

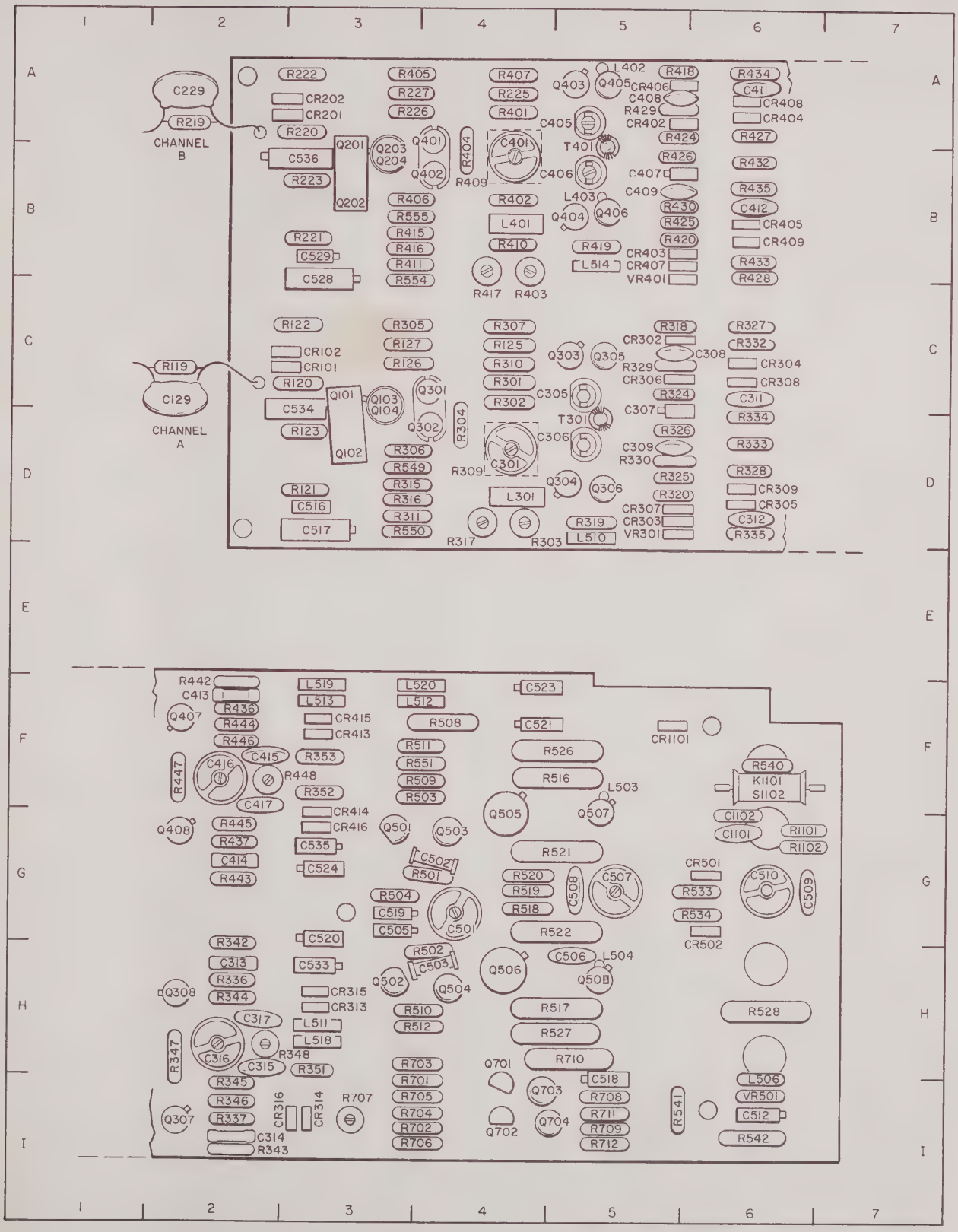


Figure 5-22. Main Amplifier Circuit Board A2A3, Location of Parts

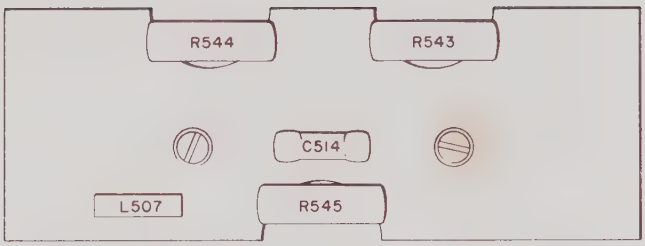


Figure 5-23. Output Circuit Board A2A4, Location of Parts

PARTS LOCATION INDEX FOR FIGURE 5-24

REF. DESIG.	DRAWING LOCATION
C601	4B
C602	3A
C603	4B
C604	3B
C607	4B
C608	4B
C612	5B
C613	3B
C614	3B
CR601	3B
CR602	3B
CR603	3A
CR604	3C

REF. DESIG.	DRAWING LOCATION
CR608	5B
CR609	5B
L601	3C
L602	3B
Q601	3A
Q602	3C
Q603	4B
Q604	4C
Q605	5B
Q606	5B
R601	4A
R602	4B
R603	4B

REF. DESIG.	DRAWING LOCATION
R604	4B
R605	4B
R606	4C
R607	3A
R608	3B
R609	3B
R610	3C
R611	3C
R615	4A
R616	4B
R617	4B
R618	5C

REF. DESIG.	DRAWING LOCATION
R619	4C
R620	5C
R621	4C
R622	4B
R626	5A
R627	5B
R628	5B
R629	5C
R630	6C
R631	5C
R632	6A
R633	5A

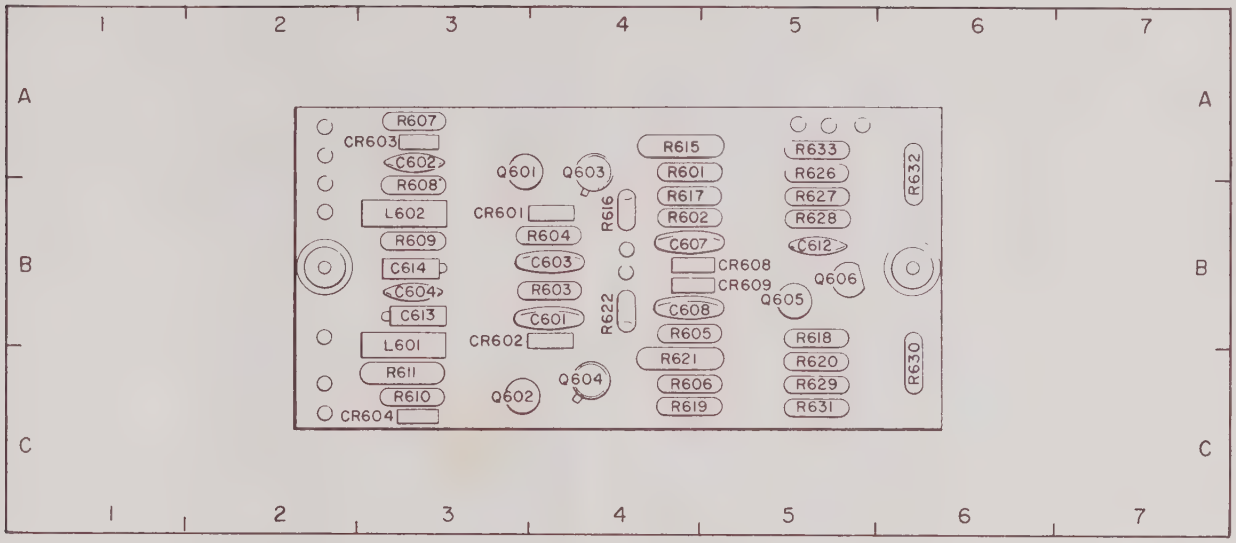
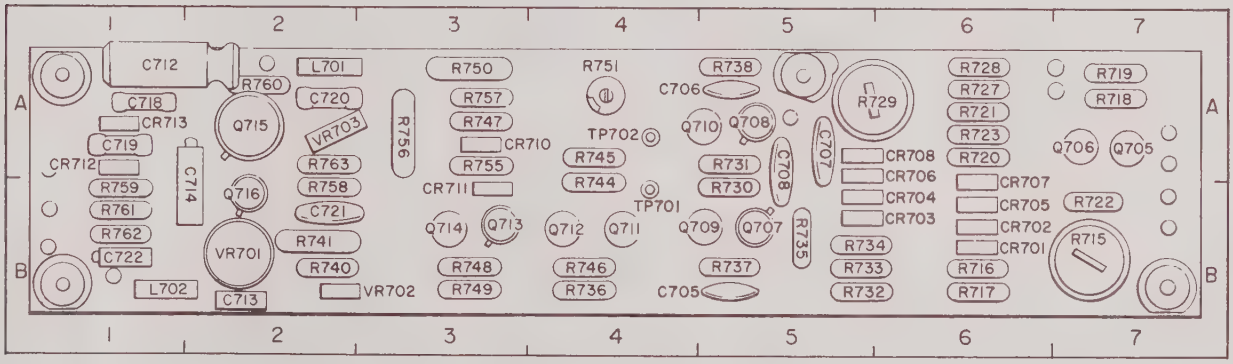


Figure 5-24. Multivibrator Circuit Board A2A5, Location of Parts



REF DESIG.	DRAWING LOCATION	REF. DESIG.	DRAWING LOCATION	REF. DESIG.	DRAWING LOCATION	REF. DESIG.	DRAWING LOCATION
C705	4B	CR711	3B	R719	7A	R74G	4B
C706	4A	CR712	1A	R720	6A	R747	3A
C707	5A	CR713	1A	R721	6A	R748	3B
C708	5A	L701	2A	R722	7B	R749	3B
C712	1A	L702	1B	R723	6A	R750	3A
C713	2B	Q705	7A	R727	6A	R751	4A
C714	2B	Q706	7A	R728	6A	R755	3A
C718	1A	Q707	5B	R729	5A	R756	3A
C719	1A	Q708	5A	R730	5A	R757	3A
C720	2B	Q709	4B	R731	5A	R758	2B
C721	2B	Q710	4A	R732	5B	R759	1A
C722	1B	Q711	4B	R733	5B	R760	2A
CR701	6B	Q712	4B	R734	5B	R761	1B
CR702	6B	Q713	3B	R735	5B	R762	1B
CR703	6B	Q714	3B	R736	4B	R763	2B
CR704	6B	Q715	2B	R737	5B	TP701	4B
CR705	6B	Q716	2B	R738	5A	TP702	4A
CR706	6A	R715	7B	R740	2B	VR701	2B
CR707	6A	R716	6B	R741	2B	VR702	3B
CR708	6A	R717	6B	R744	4A	VR703	2B
CR710	3A	R718	7A	R745	4A		

Figure 5-25. Sync Amplifier Circuit Board A2A6, Location of Parts

PARTS LOCATION INDEX FOR FIGURE 5-26

REF. DESIG.	DRAWING LOCATION
C109	2D
C111	3D
C112	3C
C113	4C
C117	4D
C118	4C
C119	5C
C120	6D
C121	5H
C122	3H
C123	3I
C201	2G
C202	3H
C203	4H
C204	5H
C205	4H
C206	6H
C208	5G
C209	5G
C307	2A
C308	3A
C310	2B
C311	3B
C312	3B
C316	4B
C317	4B
C318	5C
C319	6B
C320	6B
C324	3D
C325	3A
C326	2C
C327	5C
C328	5C
C401	3G
C402	4G
C413	2F
C414	2F
C415	4F
C416	2F
C417	3F
C418	4F
CR103	2D
CR104	3C
CR105	3C
CR106	4C
CR107	3C
CR108	4D
CR109	3C
CR110	3C
CR114	4H
CR115	2H
CR116	2H
CR117	3H
CR201	2H
CR202	2G
CR203	3G
CR204	3G

REF. DESIG.	DRAWING LOCATION
CR205	6I
CR206	6I
CR207	5H
CR301	2B
CR302	3C
CR303	3B
CR304	4B
CR305	3B
CR306	3B
CR307	3C
CR308	3C
CR309	2F
CR401	2G
CR402	3G
CR403	4G
CR404	4G
CR405	5F
CR406	5F
CR420	3F
CR421	3F
L107	4D
L108	4C
L109	4C
L110	3I
L201	4H
L302	4A
L303	4B
L304	4B
L305	5D
L306	5B
Q103	3D
Q104	2D
Q105	3D
Q106	5D
Q107	4C
Q108	5C
Q109	4I
Q110	6D
Q111	2H
Q112	4H
Q201	3H
Q202	4H
Q203	5G
Q204	5I
Q205	5H
Q301	3B
Q302	2B
Q303	3B
Q304	5B
Q305	4C
Q306	5B
Q401	3G
Q402	4F
Q403	3F
Q404	3G
R101	6F
R102	6F
R117	2D

REF. DESIG.	DRAWING LOCATION
R118	2D
R119	3D
R120	2C
R122	5D
R124	5D
R125	5D
R126	2C
R127	4D
R130	4D
R131	4D
R132	4D
R133	5C
R134	6C
R135	6C
R136	5C
R137	6D
R138	6C
R139	6D
R140	5H
R141	4H
R145	4I
R146	4I
R147	4H
R148	6C
R149	4I
R150	2I
R151	2I
R152	2H
R153	3H
R154	3H
R155	4H
R156	3H
R201	2G
R202	5H
R203	2H
R204	5H
R205	6C
R206	3H
R207	3G
R208	3H
R209	4G
R210	4H
R211	5G
R215	6F
R216	6F
R217	6G
R218	6G
R219	6G
R220	6G
R221	6H
R222	5H
R223	6I
R224	6H
R225	6H
R226	6H
R227	6F
R228	5G
R229	6H

REF. DESIG.	DRAWING LOCATION
R307	2B
R308	2B
R309	3A
R310	2B
R311	2B
R312	2C
R314	5A
R315	5A
R317	5B
R318	4B
R321	4A
R322	4A
R323	4B
R324	5B
R325	6C
R326	6C
R327	5B
R328	2F
R329	6B
R330	6B
R331	6B
R332	6B
R333	5A
R336	2D
R337	3A
R338	2D
R339	5D
R340	5B
R401	2G
R402	3F
R403	3G
R404	4G
R405	4G
R406	4G
R407	5F
R408	5F
R409	4G
R410	5F
R411	6F
R412	5F
R413	4F
R441	2F
R442	4F
R443	2F
R444	4F
R445	4F
R446	2G
R447	2G
R448	4F
TP101	5D
TP201	3H
TP203	6H
TP401	3G
V201	5G
VR101	6C
VR102	4H
VR301	6B

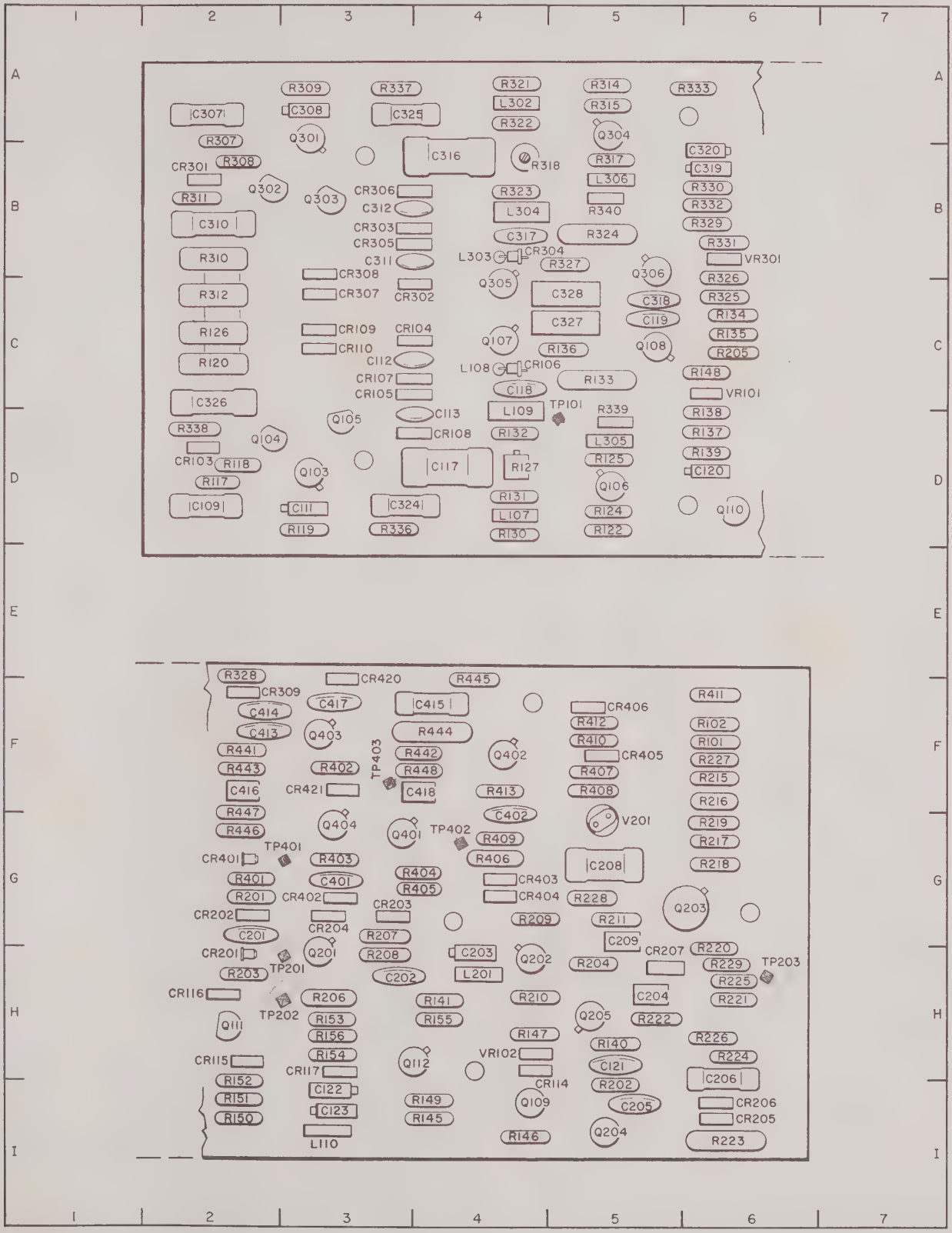


Figure 5-26. Trigger and Gate Generator Circuit Board A3A1, Location of Parts

PARTS LOCATION INDEX FOR FIGURE 5-27

REF. DESIG.	DRAWING LOCATION
C100	2C
C102	1A
C103	1B
C104	1D
C107	1C
C211	5G
C213	3F
C214	3H
C215	3G
C216	3H
C217	3G
C218	4G
C219	4G
C220	3F
C402	5C
C403	5B
C404	4B
C406	4B
C407	4C
C408	5B
C409	5B
C419	3H
C420	5C
C421	5H
C422	5H
C423	6H
C424	5F
C425	6G
C426	6G
C502	6D
C503	6C
C504	6C
C505	6B
C506	6B
C507	6C
C508	6C
C509	7B
C510	7B
C524	3D
C525	3C
C526	3C
C527	2B
C528	2B
C529	3B

REF. DESIG.	DRAWING LOCATION
C530	3B
C531	3C
C532	3C
CR210	4H
CR211	4H
CR212	3G
CR213	4G
CR214	4H
CR215	4H
CR216	4G
CR217	4G
CR218	4G
CR219	4G
CR220	4G
CR410	4D
CR411	4C
CR412	5B
CR413	5C
CR414	4B
CR415	6C
CR416	5C
CR422	5H
CR423	6H
CR424	5G
CR425	5G
L101	1B
L102	1B
L103	1C
L203	3H
L402	4C
Q101	1B
Q102	1B
Q206	2F
Q207	3H
Q208	3G
Q209	4G
Q210	4G
Q211	4G
Q405	4A
Q406	4C
Q407	4B
Q408	4B
Q409	5H
Q410	6H

REF. DESIG.	DRAWING LOCATION
Q411	5G
Q412	6H
Q413	5G
R105	1B
R106	1B
R107	1C
R108	1C
R109	1C
R110	1C
R111	1C
R232	4H
R233	4H
R234	4F
R237	4H
R238	3H
R239	3H
R240	3G
R241	3G
R245	4H
R246	2F
R247	4G
R248	4H
R249	4G
R250	4H
R251	4F
R252	3F
R253	4F
R254	5F
R255	4F
R256	4G
R257	4F
R417	4D
R418	4C
R419	5C
R422	4C
R423	4C
R424	4B
R425	4B
R429	5D
R430	3B
R431	5C
R432	4C
R433	4B
R434	5C

REF. DESIG.	DRAWING LOCATION
R435	4B
R436	5A
R437	5A
R449	4H
R450	5C
R454	5H
R455	5H
R456	5H
R457	6H
R458	6H
R459	5H
R460	5G
R461	5G
R462	5F
R463	5G
R464	5F
R468	6F
R469	6F
R470	6F
R472	6F
R473	6H
R474	6G
R513	6A
R514	6B
R515	6C
R516	6B
R517	7B
R518	7A
R519	6A
R537	2B
R538	2B
R539	3B
R540	3B
R541	3A
R542	3A
TP205	5G
TP404	5C
VR100	1B
VR201	4H
VR401	6F
VR402	6F
VR403	4C

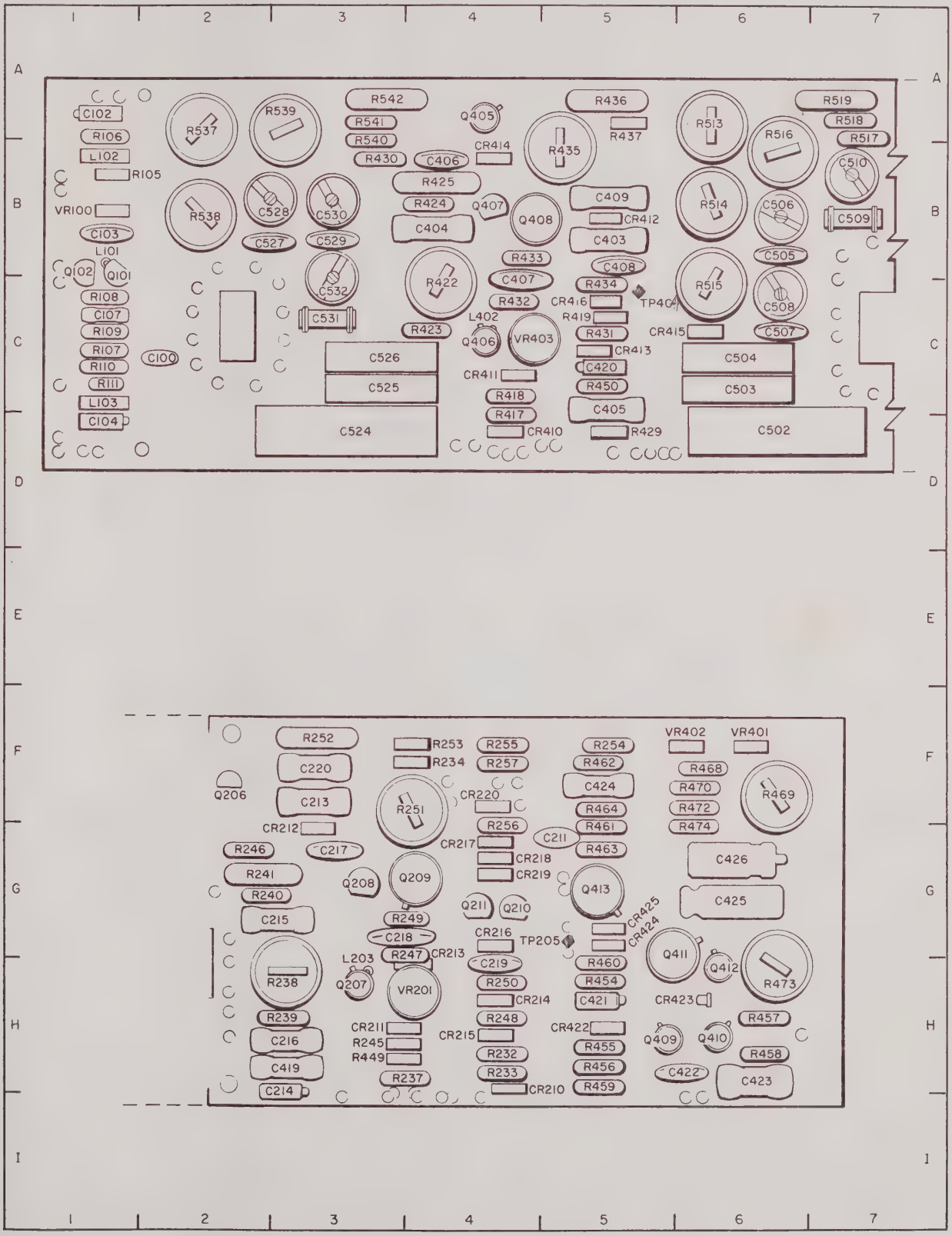


Figure 5-27. Sweep Generator Circuit Board A3A2, Location of Parts

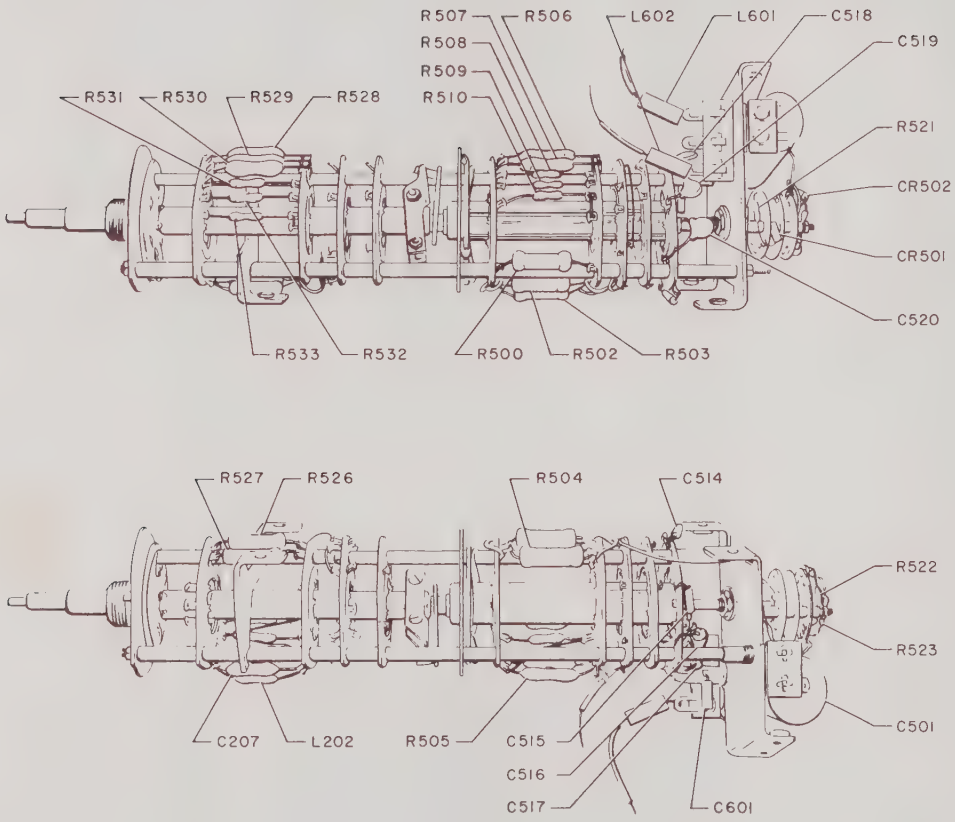
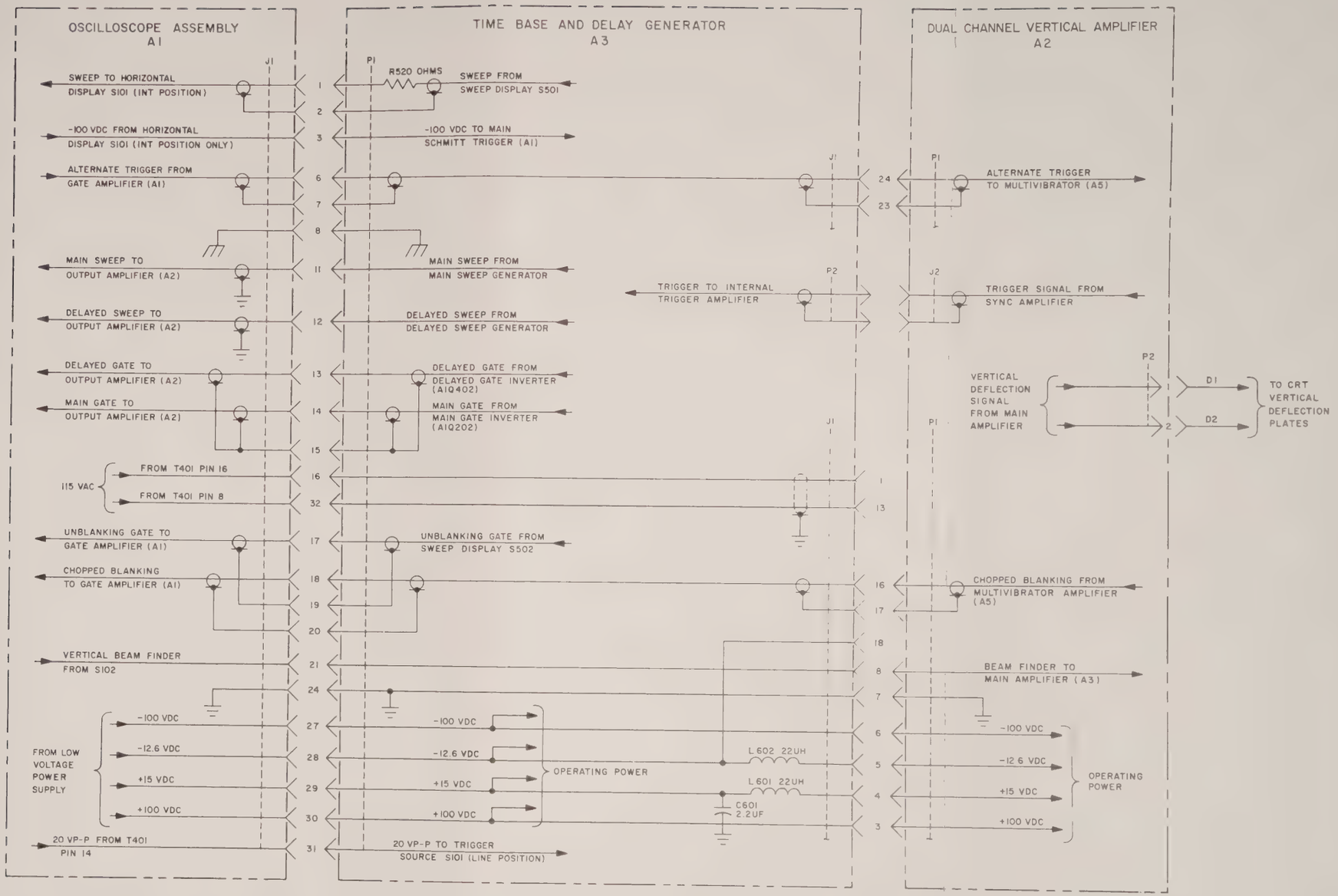


Figure 5-28. Sweep Time Switch Assembly A3A3, Location of Parts


OSCILLOSCOPE ASSEMBLY
A1
TIME BASE AND DELAY GENERATOR
A3
DUAL CHANNEL VERTICAL AMPLIFIER
A2
J1
P1
R520 OHMS
SWEEP TO HORIZONTAL DISPLAY S101 (INT POSITION)
SWEEP FROM SWEEP DISPLAY S501
-100 VDC FROM HORIZONTAL DISPLAY S101 (INT POSITION ONLY)
-100 VDC TO MAIN SCHMITT TRIGGER (A1)
ALTERNATE TRIGGER FROM GATE AMPLIFIER (A1)
ALTERNATE TRIGGER TO MULTIVIBRATOR (A5)
MAIN SWEEP TO OUTPUT AMPLIFIER (A2)
MAIN SWEEP FROM MAIN SWEEP GENERATOR
TRIGGER TO INTERNAL TRIGGER AMPLIFIER
P2
J2
TRIGGER SIGNAL FROM SYNC AMPLIFIER
DELAYED SWEEP TO OUTPUT AMPLIFIER (A2)
DELAYED SWEEP FROM DELAYED SWEEP GENERATOR
DELAYED GATE TO OUTPUT AMPLIFIER (A2)
DELAYED GATE FROM DELAYED GATE INVERTER (A1Q402)
MAIN GATE TO OUTPUT AMPLIFIER (A2)
MAIN GATE FROM MAIN GATE INVERTER (A1Q202)
VERTICAL DEFLECTION SIGNAL FROM MAIN AMPLIFIER
D1
D2
TO CRT VERTICAL DEFLECTION PLATES
115 VAC
FROM T401 PIN 16
FROM T401 PIN 8
UNBLANKING GATE TO GATE AMPLIFIER (A1)
UNBLANKING GATE FROM SWEEP DISPLAY S502
CHOPPED BLANKING TO GATE AMPLIFIER (A1)
CHOPPED BLANKING FROM MULTIVIBRATOR AMPLIFIER (A5)
VERTICAL BEAM FINDER FROM S102
BEAM FINDER TO MAIN AMPLIFIER (A3)
FROM LOW VOLTAGE POWER SUPPLY
-100 VDC
-12.6 VDC
+15 VDC
+100 VDC
OPERATING POWER
L602 22UH
L601 22UH
C601 2.2UF
20 VP-P FROM T401 PIN 14
20 VP-P TO TRIGGER SOURCE S101 (LINE POSITION)

NOTE: All reference designators in parentheses are preceded by main assembly designators.

Figure 5-29. Interconnecting Schematic Diagram

PARTS LOCATION INDEX

REF. DESIG.	DRAWING LOCATION
C101	3B
C102	4C
C103	4D
C104	6B
C105	7B
C106	8B
C110	7B
C111	7C
C112	8D
C113	7C
C114	8C
C115	10B
C116	10D
C120	3F
C121	5G
C122	6G
C123	6I
C127	15I
C128	15I
CR101	6D
CR102	5D
CR103	5D
CR104	5E
CR105	6A
CR109	10C
CR110	10C
CR111	11D
CR112	11C
CR113	11C
CR115	6G
CR116	4H
CR117	6H
J101	2B
J102	9F
J103	9G
J104	9G
J105	16B
J106	16C
J107	16E
J108	16G
L101	2B
L102	7A
L105	5I
L107	14H
L108	14I
Q101	5D
Q102	6D
Q103	9B
Q104	9D
Q105	11D
Q106	4H
Q107	6H
Q108	15A
Q109	15C
Q110	15E
Q111	15G
R101	3B
R102	4A
R103	4B
R104	4C
R105	4C
R106	3D
R107	4D
R111	5A
R112	6A
R113	7A
R114	5D
R115	7C
R116	6D
R117	7D
R118	8D
R119	7C
R120	7C
R121	7C
R125	8B
R126	9B
R127	9B
R128	11D
R129	11D
R130	10D
R131	11E
R132	12E
R133	11B
R136	4G
R137	5H
R138	5H
R139	5F
R140	5F
R141	5F
R142	6G
R143	6F
R144	6F
R145	6G
R149	14A
R150	14B
R151	15B
R152	14C
R153	14D
R154	15D
R155	14E
R156	14F
R157	15F
R158	14G
R159	14H
R160	15H
R161	14I
R162	15I
S101	2C
S102	2D

NOTES:

1. Unless otherwise indicated, electrical values for resistors, coils and capacitors are expressed in ohms, microhenries or picofarads.
2. All reference designators preceded by A1.
3. Dc voltage measurements taken with ME-243/FQM Electronic Voltmeter (or equivalent). Control settings as follows:
   Horizontal DISPLAY to EXT CAL
   Vertical DISPLAY to A
   Adjust INTENSITY for +57 vdc on collectors of Q103 & Q104
4. Numbers in parentheses indicate wire color using resistor color code.
   Example: White-Orange-Green is (935).
5. Primary signal paths weighted. Feedback paths weighted and dashed.

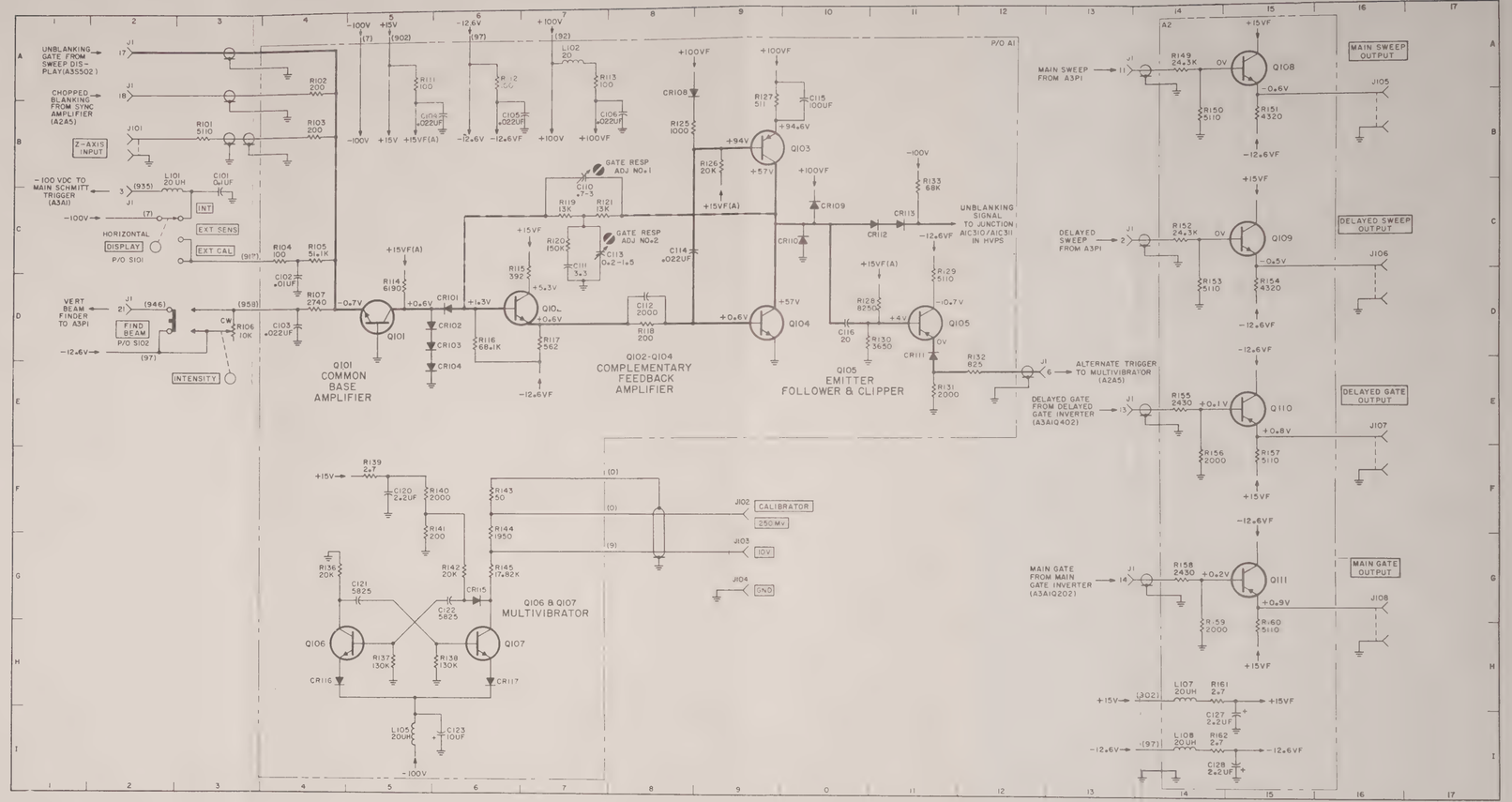


Figure 5-30. Oscilloscope Assembly Schematic Diagram (Sheet 1 of 4)

PARTS LOCATION INDEX

REF. DESIG.	DRAWING LOCATION	REF. DESIG.	DRAWING LOCATION	REF. DESIG.	DRAWING LOCATION	REF. DESIG.	DRAWING LOCATION
C201	1D	CR206	13H	R206	7D	R246	12F
C202	4C	CR207	13H	R207	7C	R247	12F
C203	6D	CR208	13H	R208	7C	R248	12E
C204	6D	CR209	14F	R209	7D	R249	12F
C205	10C	J201	1D	R210	8B	R250	12F
C206	10C	L200	9F	R211	8C	R251	12F
C210	15A	L201	9F	R215	10B	R252	13E
C211	15C	L202	9G	R216	10C	R253	13E
C212	15D	L203	10B	R217	10C	R254	13F
C213	15E	Q201	5C	R218	10D	R257	11G
C214	15E	Q202	6D	R219	11C	R258	11G
C216	9F	Q203	11B	R220	11C	R259	12H
C219	9F	Q204	12B	R221	10D	R261	13H
C220	9G	Q205	12G	R222	11B	R262	13H
C221	9H	Q206	13B	R223	12B	R263	14H
C222	9I	Q207	13G	R225	13B	R264	14H
C226	11H	Q208	15B	R229	14B	R268	14G
C227	13I	Q209	15B	R230	14B	R269	15G
C228	14I	Q210	15C	R231	14C	R270	14F
C229	15H	Q211	15H	R232	15B	R271	14G
C230	15G	Q212	15H	R234	14C	R273	15F
C231	15F	Q213	15F	R235	14D	R275	16F
CR201	4D	R201	4C	R237	15D	S101	3C-9C
CR202	13B	R202	4D	R238	16D	S102	13I
CR203	13B	R203	5C	R239	16E	S201	2D
CR204	14B	R204	5D	R244	9H	S202	6D
CR205	14C	R205	6D	R245	9H	S203	12E

NOTES:

1. Unless otherwise indicated, electrical values for resistors, coils and capacitors are expressed in ohms, microhenries or picofarads.
2. The letters cw placed adjacent to the appropriate terminal of a potentiometer indicate maximum clockwise rotation as viewed from the shaft end.
3. All reference designators preceded by A1.
4. Dc voltage measurements taken with ME-243/FQM Electronic Voltmeter (or equivalent). Control settings as follows:
   Horizontal DISPLAY to EXT CAL
   Horizontal MAGNIFIER to X1
   HORIZONTAL POSITION to center spot
5. Primary signal paths weighted. Feedback paths weighted and dashed.

▷ Voltages listed for Q201 are typical. Actual voltages vary with the characteristics of the FET.

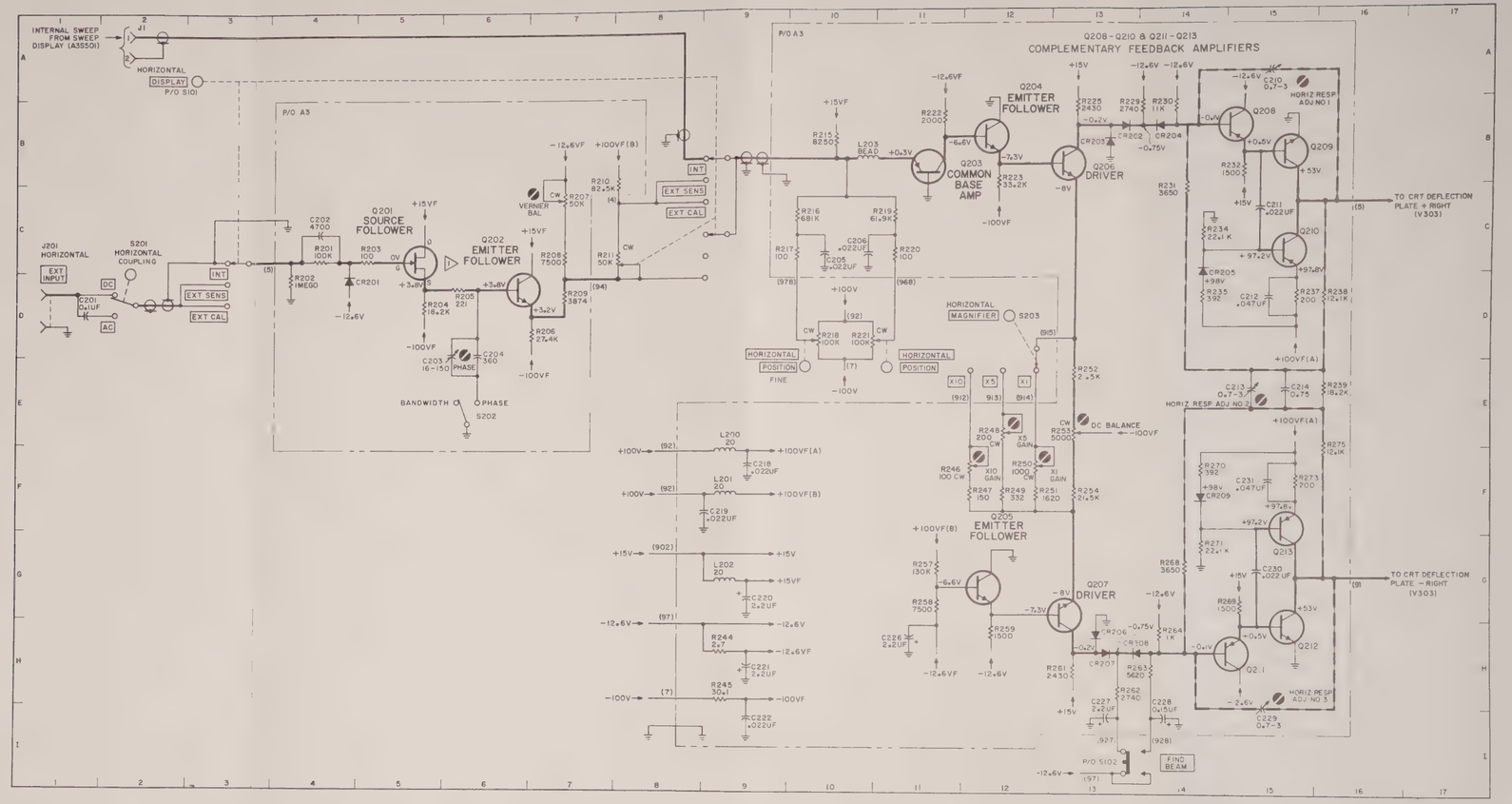


Figure 5-30. Oscilloscope Assembly Schematic Diagram (Sheet 2 of 4)

PARTS LOCATION INDEX

REF. DESIG	DRAWING LOCATION
C301	2B
C302	2F
C303	2F
C307	7B
C308	6D
C309	9D
C310	11D
C311	12D
C315	10E
C316	11E
C317	11E
C318	9F
C319	9G
C320	10G
C321	10G
CR301	7C
CR302	9D
CR307	9E
CR308	9G
CR309	10G

REF. DESIG	DRAWING LOCATION
CR310	10G
F301	7B
J2	14E
L301	7D
L302	15B
L303	15B
Q301	2D
Q302	3D
Q303	5D
Q304	8B
R301	2B
R302	2C
R303	2C
R304	2D
R305	2F
R313	3C
R314	3C
R315	3E
R316	3D

REF. DESIG	DRAWING LOCATION
R317	3E
R318	4D
R319	5D
R320	5D
R321	6D
R325	9D
R326	9D
R327	10D
R328	11D
R330	13C
R331	13D
R332	14C
R333	14D
R334	16A
R335	16B
R336	16B
R337	16B
R341	11E
R342	10G

REF. DESIG	DRAWING LOCATION
R343	11E
R344	11F
R345	11G
R346	13E
R347	13G
R348	14G
R349	14H
R350	16F
R351	15G
R352	15H
R353	15G
R354	15H
T301	8B
TP301	11E
V301	11D
V302	11E
V303	14E
VR301	4D
VR302	5D

NOTES:

1. Unless otherwise indicated, electrical values for resistors, coils and capacitors are expressed in ohms, microhenries or picofarads.
2. The letters cw placed adjacent to the appropriate terminal of a potentiometer indicate the maximum clockwise rotation as viewed from the shaft end.
3. All reference designators preceded by A1.
4. Dc voltage measurements taken with ME-243/FQM Electronic Voltmeter (or equivalent).
5. ☠ signifies dangerously high voltages exist. Keep Clear! Use extreme care when measuring.
6. Numbers in parentheses indicate wire color using resistor color code. Example: White-Brown-Blue is (916).
7. Primary signal paths weighted. Feedback paths weighted and dashed.

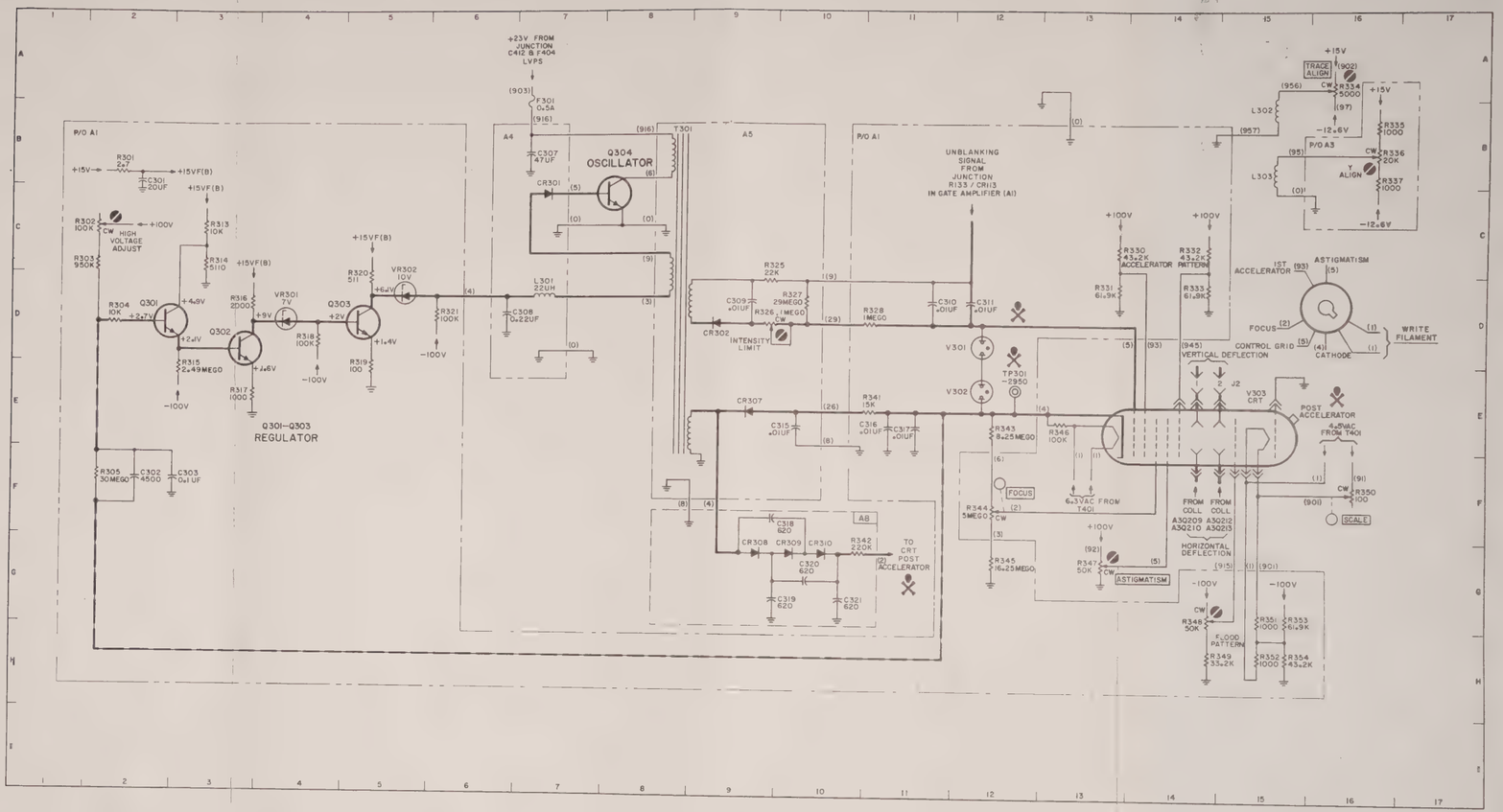


Figure 5-30. Oscilloscope Assembly Schematic Diagram (Sheet 3 of 4)

PARTS LOCATION INDEX

REF. DESIG.	DRAWING LOCATION	REF. DESIG.	DRAWING LOCATION	REF. DESIG.	DRAWING LOCATION	REF. DESIG.	DRAWING LOCATION
C401	5A	CR419	12E	Q409	8F	R430	10F
C405	6C	CR420	12G	Q410	9F	R431	11F
C406	7C	CR421	4F	Q411	11F	R432	12F
C407	14C	CR422	4F	Q412	11G	R433	13F
C408	15B	CR423	4F	Q413	8H	R434	13G
C412	6E	CR424	4F	Q414	10H	R435	13G
C413	7E	CR425	12G	Q415	12I	R439	5G
C414	14D	CR426	4H	Q416	13H	R440	5I
C418	6G	CR427	4H	R401	11A	R441	8H
C419	7G	CR428	4H	R402	5B	R442	7I
C420	14F	CR429	4H	R403	5C	R443	10I
C424	6I	CR430	15H	R404	8B	R444	12H
C425	7I	CR432	11H	R405	8C	R445	13H
C426	14H	CR433	12I	R406	10C	R446	13I
C427	15H	CR434	13I	R407	12C	R447	14H
CR401	5A	DS401	3C	R408	11B	R448	14H
CR402	5B	F401	2B	R409	13C	R449	14H
CR403	4A	F402	1B	R410	14B	R450	14I
CR404	4B	F403	6B	R411	14B	S401	2C
CR405	11C	F404	6D	R412	14C	S402	2E
CR406	12C	F405	6F	R413	14C	T401	3A
CR407	14C	F406	6H	R417	7E	TP401	15B
CR408	4B	FL401	2B	R418	9D	TP402	15D
CR409	4B	J402	2F	R419	10D	TP403	15G
CR410	4B	Q401	10B	R420	11D	TP404	15I
CR411	4B	Q402	8B	R421	12E	V401	12C
CR412	15B	Q403	12C	R422	13D	V402	12I
CR413	4D	Q404	13C	R423	13E	VR401	11A
CR414	4D	Q405	8D	R424	13E	VR402	8B
CR415	4D	Q406	9D	R428	8G	VR403	8H
CR416	4D	Q407	11D	R429	9F	W401	2A
CR417	12E	Q408	11E				

NOTES:

1. Unless otherwise indicated, electrical values for resistors and capacitors are expressed in ohms or picofarads.
2. The letters cw placed adjacent to the appropriate terminal of a potentiometer indicate the maximum clockwise rotation as viewed from the shaft end.
3. Voltages measured with a ME-243/FQM Electronic Voltmeter (or equivalent).
4. All reference designators preceded by A1.
5. Numbers in parentheses indicate wire color using resistor color code. Example: White-Red-Blue is (926).
6. Primary signal paths weighted. Feedback paths weighted and dashed.

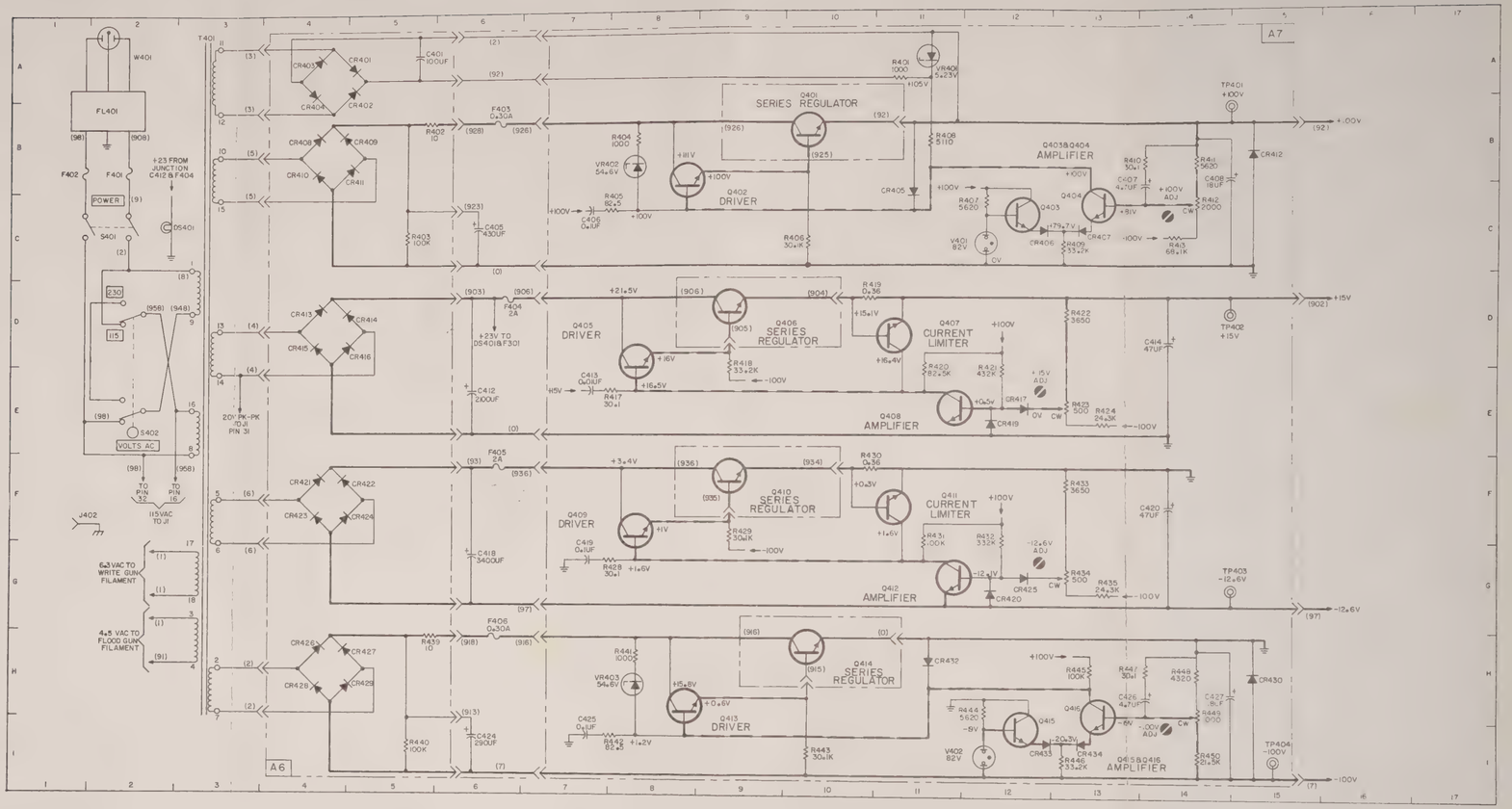


Figure 5-30. Oscilloscope Assembly Schematic Diagram (Sheet 4 of 4)

PARTS LOCATION INDEX

REF. DESIG.	DRAWING LOCATION
C101	3B
C103	5C
C104	5C
C105	6B
C107	5D
C108	5D
C109	5C
C110	6D
C112	5D
C113	5D
C114	5D
C115	6D
C118	8C
C119	9C
C120	9B
C121	9C
C123	8D
C124	9D
C125	9C
C126	9D
C128	11B
C129	12B
C130	13C
C201	3F
C203	5G
C204	5G
C205	6G
C207	5H
C208	5H
C209	5G
C210	6H
C212	5I
C213	5I
C214	5H
C215	6I
C218	8H
C219	9H
C220	9G
C221	9G
C223	8I
C224	9I
C225	9H
C226	9H
C228	11G
C229	12F
C230	13G
CR101	13B
CR102	13B
CR201	13F
CR202	13F
J101	2B
J201	2F
L101	13C
L201	13G
Q101	14B
Q102	14D
Q103	15B
Q104	15D
Q201	14F
Q202	14H
Q203	15F
Q204	15H
R100	2B
R101	6C
R102	6C
R104	5C
R105	6D
R107	5D
R108	6D
R111	9B
R112	9C
R113	10C
R115	9D
R116	10D
R118	11B
R119	12B
R120	14B
R121	14D
R122	14B
R123	14D
R124	14C
R125	16C
R126	15C
R127	15D
R200	2F
R201	6G
R202	6G
R204	5G
R205	6H
R207	5H
R208	6I
R216	10I
R218	11G
R219	12F
R220	14F
R221	14I
R222	14G
R223	14H
R224	14G
R225	16G
R226	15G
R227	15H
S101	2B
S102	4B-4E, 7B-7E, 10A-10E
S201	2F
S202	4F-4I, 7F-7I 10F-10I

NOTES:

1. Unless otherwise indicated, electrical values for resistors, coils and capacitors are expressed in ohms, microhenries or picofarads.
2. The letters cw placed adjacent to the appropriate terminal of a potentiometer indicate the maximum clockwise rotation as viewed from the shaft end.
3. All reference designators preceded by A2.
4. Dc voltage measurements taken with ME-243/FQM Electronic Voltmeter (or equivalent).
5. Numbers in parentheses indicate wire color using resistor color code. Example: Yellow is (4).
6. Primary signal paths weighted.

▷ Voltages listed for Q101, Q102, Q201, and Q202 are typical. Actual voltages vary with the characteristics of the FET.

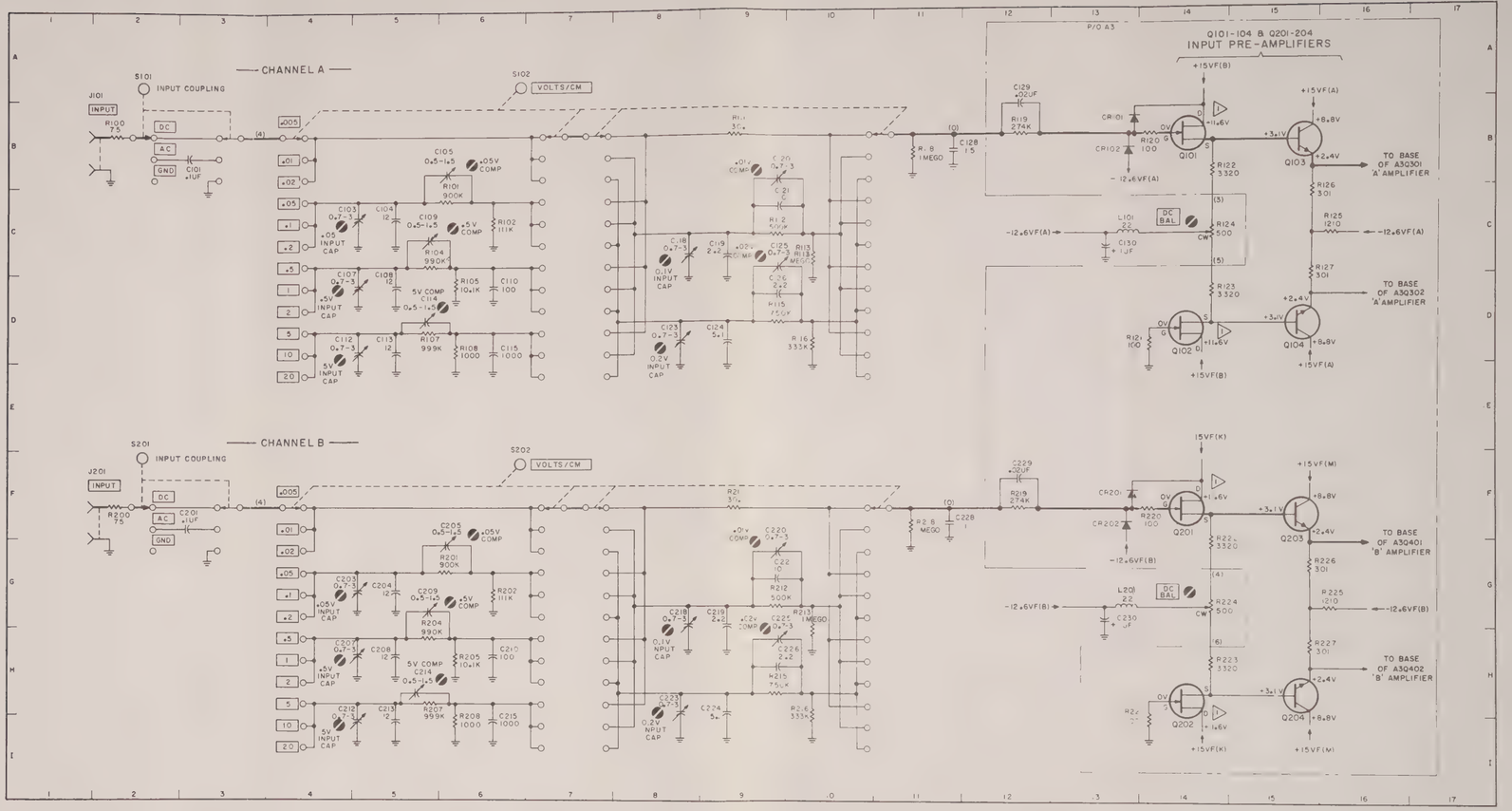


Figure 5-31. Dual Channel Vertical Amplifier Schematic Diagram (Sheet 1 of 5)

PARTS LOCATION INDEX

REF. DESIG.	DRAWING LOCATION	REF. DESIG.	DRAWING LOCATION	REF. DESIG.	DRAWING LOCATION	REF. DESIG.	DRAWING LOCATION
C301	3D	CR404	8F	R311	4D	R409	4G
C305	6C	CR405	8H	R315	4D	R410	4H
C306	7C	CR406	10F	R316	5E	R411	4I
C307	7C	CR407	10I	R317	5D	R415	4I
C308	8A	CR408	10F	R318	6B	R416	4I
C309	8E	CR409	10I	R319	6D	R417	5I
C311	11A	CR413	14F	R320	5C	R418	6F
C312	11E	CR414	14I	R324	7B	R419	6H
C313	13B	CR415	15F	R325	7D	R420	5G
C314	13E	CR416	15I	R326	7C	R424	7F
C315	13B	L301	5D	R327	8C	R425	7H
C316	14B	L401	5I	R328	8C	R426	7G
C317	14B	L402	8E	R329	7A	R427	8G
C401	3H	L403	8I	R330	8E	R428	8H
C405	6G	Q301	2B	R332	10C	R429	7E
C406	7H	Q302	2D	R333	10C	R430	8I
C407	7H	Q303	6A	R334	11B	R432	10G
C408	8E	Q304	6D	R335	11D	R433	10H
C409	9I	Q305	8A	R336	12B	R434	11F
C411	11F	Q306	8D	R337	12D	R435	11I
C412	11I	Q307	12D	R338	12C	R436	12F
C413	13F	Q308	12B	R342	13A	R437	12I
C414	13I	Q401	2F	R343	13D	R438	12G
C415	13H	Q402	2I	R344	12B	R442	13F
C416	14H	Q403	6F	R345	12D	R443	13I
C417	14H	Q404	6I	R346	13D	R444	12G
CR302	10B	Q405	8F	R347	13C	R445	12H
CR303	10D	Q406	8I	R348	14C	R446	13G
CR304	10B	Q407	12F	R351	15C	R447	13G
CR305	10D	Q408	12I	R352	16B	R448	14G
CR306	8B	R301	2B	R353	16D	S301	9C
CR307	8D	R302	2D	R354	16C	S302	16C-16D
CR308	8B	R303	2C	R401	2G	S401	9G
CR309	8D	R304	3B	R402	2H	T301	6C
CR313	14B	R305	3A	R403	2G	T401	6G
CR314	14D	R306	3D	R404	3G	VR301	5C
CR315	15A	R307	4A	R405	3F	VR401	5H
CR316	15D	R308	4C	R406	3I		
CR402	8F	R309	4B	R407	4F		
CR403	8H	R310	4B	R408	4G		

NOTES:

1. Unless otherwise indicated, electrical values for resistors, coils and capacitors are expressed in ohms, microhenries or picofarads.
2. The letters cw placed adjacent to the appropriate terminal of a potentiometer indicate the maximum clockwise rotation as viewed from the shaft end.
3. All reference designators preceded by A2.
4. Dc voltage measurements taken with ME-243/FQM Electronic Voltmeter (or equivalent).
   Control settings as follows:
   Horizontal MAGNIFIER to X1
   Horizontal DISPLAY to INT
   Vertical MAGNIFIER to X1
   Vertical DISPLAY to A
   POLARITY (both channels) to +UP
   VOLTS/CM (both channels) to 1
   Vernier VOLTS/CM (both channels) to CAL
   Input coupling (both channels) to GND
   A POSITION to center trace
5. Numbers in parentheses indicate wire color using resistor color code.
   Example: White-Black-Yellow is (904).
6. Primary signal paths weighted.

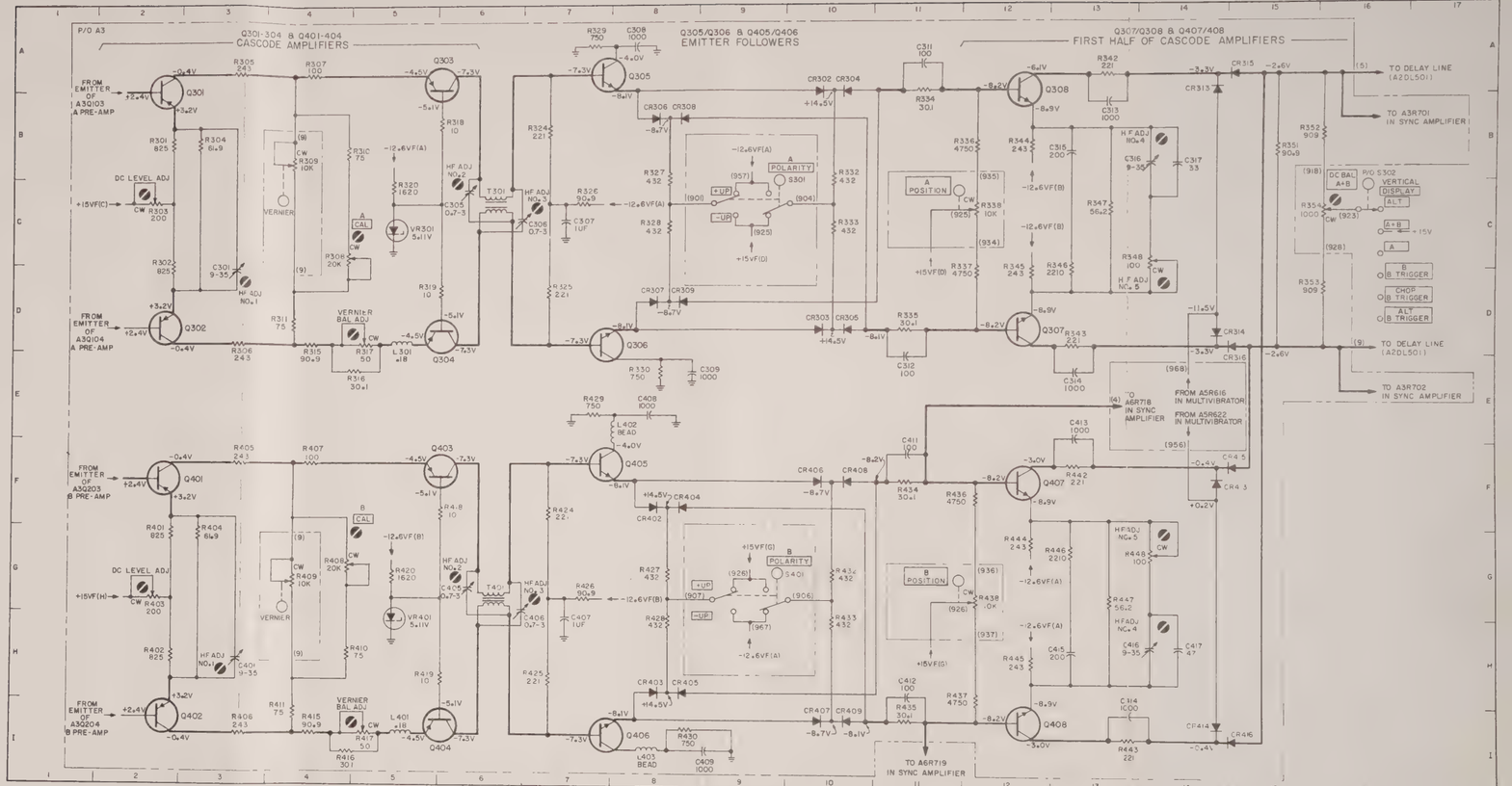


Figure 5-31. Dual Channel Vertical Amplifier Schematic Diagram (Sheet 2 of 5)

PARTS LOCATION INDEX

REF. DESIG.	DRAWING LOCATION
C501	3D
C502	3B
C503	3E
C505	3D
C506	8D
C507	7C
C508	8D
C509	11C
C510	11C
C512	13D
C514	15D
C516	2H
C517	3H
C518	5H
C519	4H
C520	4H
C521	5H
C523	5H
C524	6H
C526	7H
C529	8H
C533	9H
C534	10H
C535	10H
C536	11H
C1101	10D

REF. DESIG.	DRAWING LOCATION
C1102	10D
CR501	12C
CR502	12D
CR1101	9D
DL501	3B-3E
K1101	9C
L503	9C
L504	9E
L506	11B
L507	15D
L510	4H
L511	4H
L512	5H
L513	6H
L514	6H
L518	9H
L519	11H
L520	12H
P1	11B-13B
P2	16B-16E
Q501	4C
Q502	4E
Q503	6B
Q504	6E
Q505	7C
Q506	7E

REF. DESIG.	DRAWING LOCATION
Q507	9B
Q508	9F
Q509	10C
Q510	10E
Q511	12C
Q512	12E
R501	3B
R502	3E
R503	5D
R504	5D
R508	5D
R509	6C
R510	6E
R511	6C
R512	6E
R516	7B
R517	7F
R518	7D
R519	8D
R520	8D
R521	8D
R522	8D
R526	9C
R527	9E
R528	10B
R529	10B

REF. DESIG.	DRAWING LOCATION
R530	10F
R531	10C
R532	10D
R533	11D
E534	11D
R538	11B
R539	11E
R540	12C
R541	12E
R542	13D
R543	14C
R544	14E
R545	15D
R549	2H
R550	3H
R551	5G
R554	7H
R555	8H
R1101	9D
R1102	10D
S1101	8E
S1102	9C
VR501	13D

NOTES:

1. Unless otherwise indicated, electrical values for resistors, coils and capacitors are expressed in ohms, microhenries or picofarads.
2. All reference designators preceded by A2.
3. Dc voltage measurements taken with ME-243/FQM Electronic Voltmeter (or equivalent). Control settings as follows:
   Horizontal MAGNIFIER to X1
   Horizontal DISPLAY to INT
   Vertical MAGNIFIER to X1
   Vertical DISPLAY to A
   POLARITY (both channels) to +UP
   VOLTS/CM (both channels) to 1
   Vernier VOLTS/CM (both channels) to CAL
   Input coupling (both channels) to GND
   A POSITION to center trace
4. Numbers in parentheses indicate wire color using resistor color code. Example: White-Yellow-Blue is (946).
5. Primary signal paths weighted.

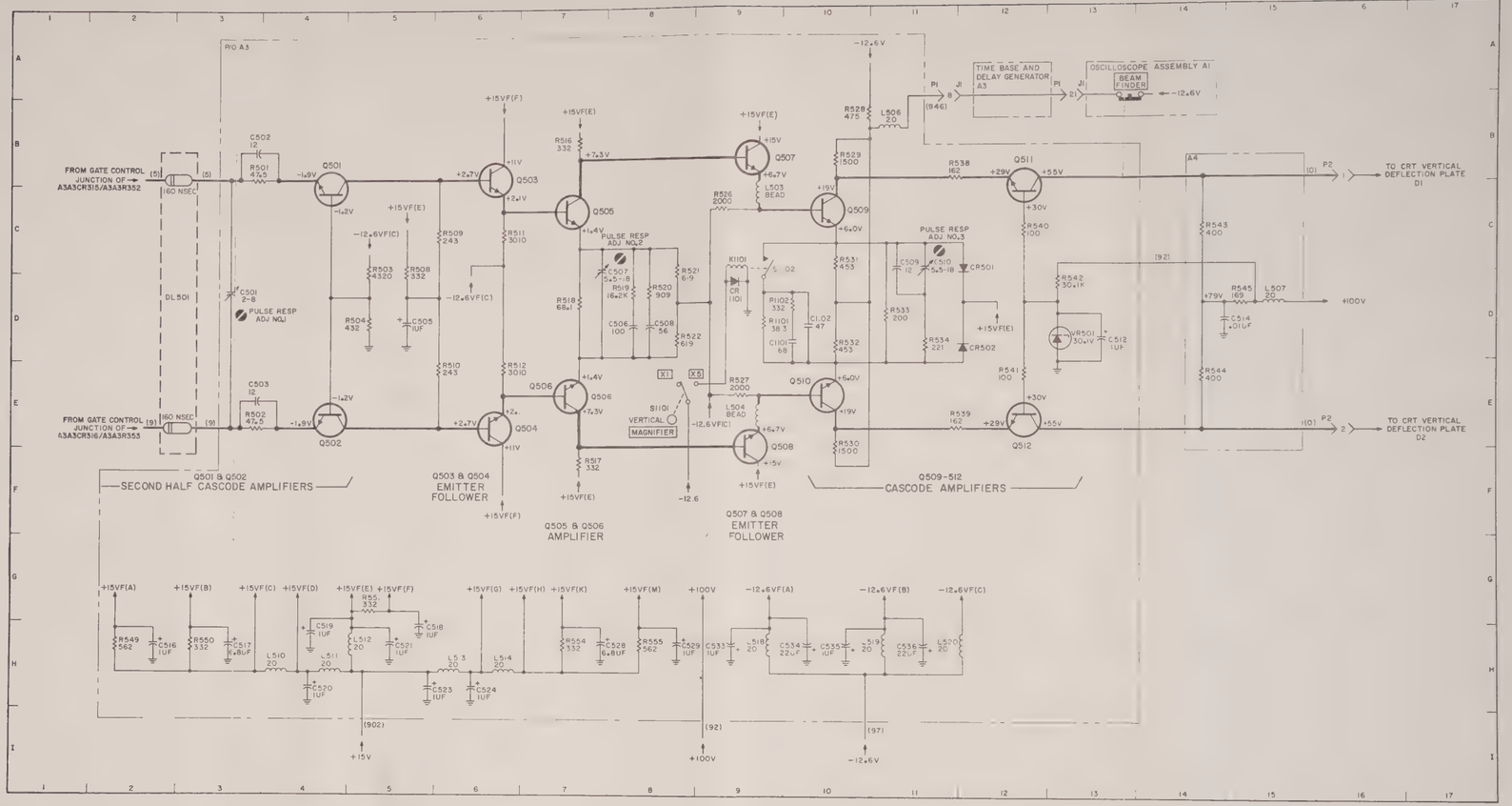

P/O A3
FROM GATE CONTROL JUNCTION OF A3A3CR315/A3A3R352
FROM GATE CONTROL JUNCTION OF A3A3CR316/A3A3R353
160 NSEC
DL501
PULSE RESP ADJ NO1
PULSE RESP ADJ NO2
PULSE RESP ADJ NO3
Q501 & Q502 SECOND HALF CASCODE AMPLIFIERS
Q503 & Q504 EMITTER FOLLOWER
Q505 & Q506 AMPLIFIER
Q507 & Q508 EMITTER FOLLOWER
Q509-512 CASCODE AMPLIFIERS
VERTICAL MAGNIFIER
TIME BASE AND DELAY GENERATOR A3
OSCILLOSCOPE ASSEMBLY A1
BEAM FINDER
TO CRT VERTICAL DEFLECTION PLATE D1
TO CRT VERTICAL DEFLECTION PLATE D2

Figure 5-31. Dual Channel Vertical Amplifier Schematic Diagram (Sheet 3 of 5)

PARTS LOCATION INDEX

REF. DESIG.	DRAWING LOCATION	REF. DESIG.	DRAWING LOCATION	REF. DESIG.	DRAWING LOCATION	REF. DESIG.	DRAWING LOCATION
C601	3E	CR608	10C	R603	4E	R619	8D
C602	5F	CR609	10D	R604	6E	R620	9D
C603	6E	L601	13D	R605	6D	R621	8E
C604	7G	L602	13E	R606	7D	R622	9E
C605	4H	P1	2F-14C	R607	4G	R626	11D
C607	9C	Q601	3E	R608	4G	R627	11E
C608	9D	Q602	7E	R609	5G	R628	11C
C612	12C	Q603	8B	R610	6G	R629	11D
C613	13D	Q604	8E	R611	7G	R630	12D
C614	13E	Q605	11D	R615	8B	R631	13C
CR601	3D	Q606	13C	R616	9B	R632	13C
CR602	6D	R601	3D	R617	8C	S302	3H-I, 4H-I, 5H-I, 7H-I, 10D-F.
CR603	4F	R602	3D	R618	9C		
CR604	5F						

NOTES:

1. Unless otherwise indicated, electrical values for resistors, coils and capacitors are expressed in ohms, microhenries or picofarads.
2. All reference designators preceded by A2.
3. Dc voltage measurements taken with ME-243/FQM Electronic Voltmeter (or equivalent). Control settings as follows:
   Vertical DISPLAY to A
   POLARITY (both channels) to +UP
   VOLTS/CM (both channels) to 1
   Vernier VOLTS/CM (both channels) to CAL
   Input coupling (both channels) to GND
   A POSITION to center trace
4. Numbers in parentheses indicate wire color using resistor color code.
   Example: White-Green-Blue is (956).
5. Primary signal paths weighted.

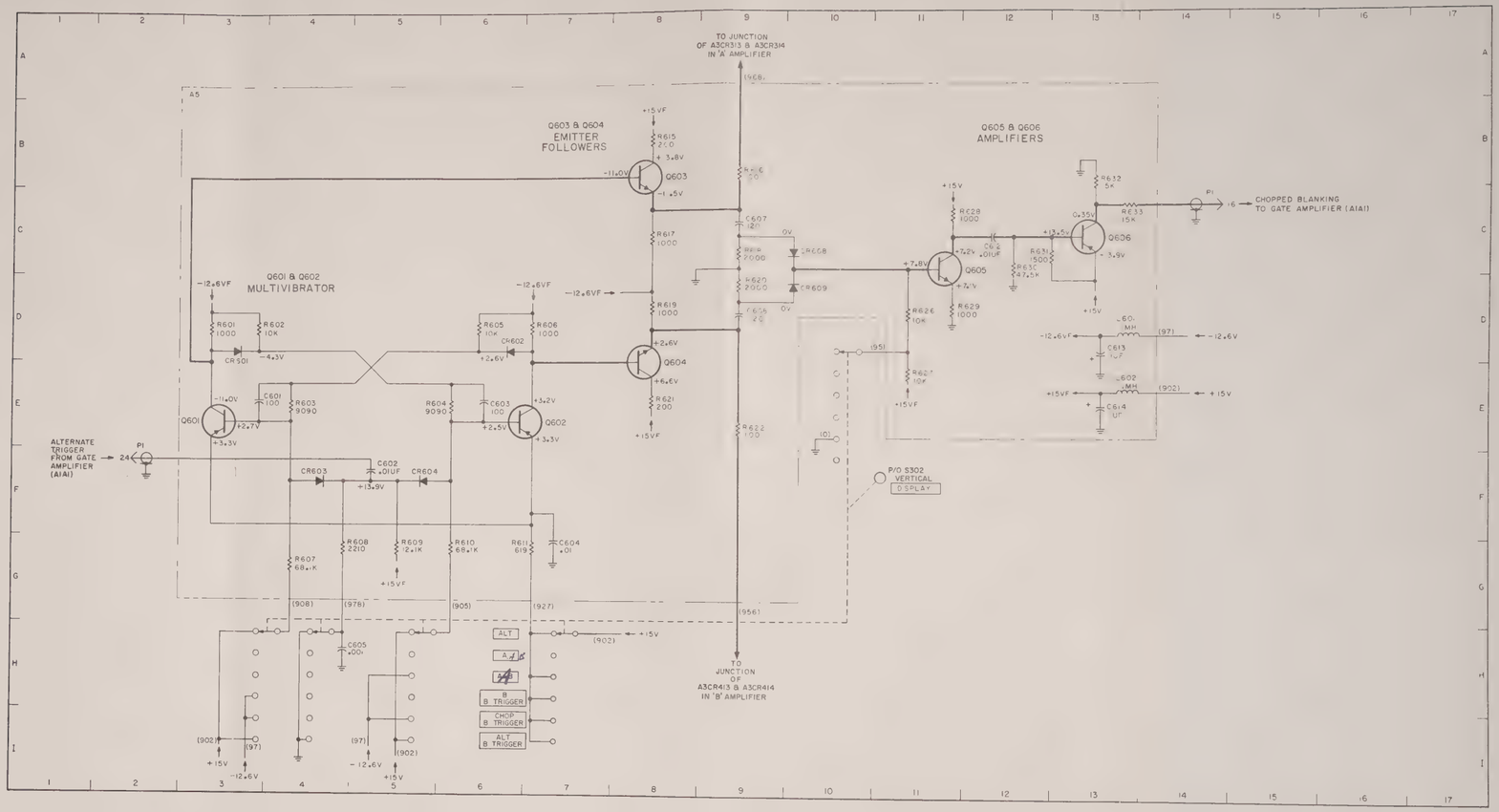


Figure 5-31. Dual Channel Vertical Amplifier Schematic Diagram (Sheet 4 of 5)

PARTS LOCATION INDEX

REF. DESIG.	DRAWING LOCATION	REF. DESIG.	DRAWING LOCATION	REF. DESIG.	DRAWING LOCATION	REF. DESIG.	DRAWING LOCATION
C705	11B	L702	11G	R710	5B	R744	12C
C706	11G	Q701	3B	R711	5C	R745	12E
C707	11E	Q702	3G	R712	5F	R746	12C
C708	11D	Q703	4B	R715	6D	R747	12E
C712	10G	Q704	4F	R716	6C	R748	12G
C713	10G	Q705	7A	R717	6E	R749	12G
C714	11G	Q706	7G	R718	7A	R750	12D
C718	15C	Q707	10C	R719	7G	R751	12E
C719	15D	Q708	10F	R720	8B	R755	13E
C720	15F	Q709	11C	R721	7G	R756	14E
C721	14F	Q710	11F	R722	8B	R757	14F
C722	15F	Q711	12B	R723	8G	R758	14F
CR701	6C	Q712	12F	R727	9C	R759	15C
CR702	6C	Q713	13F	R728	9E	R760	15E
CR703	6F	Q714	14F	R729	9D	R761	15F
CR704	6F	Q715	15E	R730	10C	R762	15F
CR705	9B	Q716	15G	R731	10F	R763	15G
CR706	9B	R701	3B	R732	10D	S302	7D-7E, 8D-8E, 16B-16C
CR707	9G	R702	3G	R733	10E		
CR708	9G	R703	3A	R734	10D	TP701	12B
CR710	14E	R704	3G	R735	11D	TP702	12G
CR711	13F	R705	3C	R736	11E	VR701	11G
CR712	15C	R706	3E	R737	11B	VR702	13G
CR713	15D	R707	3D	R738	11F	VR703	15F
J2	16F	R708	5C	R740	11G		
L701	9G	R709	5E	R741	11G		

NOTES:

1. Unless otherwise indicated, electrical values for resistors, coils and capacitors are expressed in ohms, microhenries or picofarads.
2. The letters cw placed adjacent to the appropriate terminal of a potentiometer indicate the maximum clockwise rotation as viewed from the shaft end.
3. All reference designators preceded by A2.
4. Dc voltage measurements taken with ME-243/FQM Electronic Voltmeter (or equivalent).

   Control settings as follows:
   Vertical DISPLAY to A
   POLARITY (both channels) to +UP
   VOLTS/CM (both channels) to 1
   Vernier VOLTS/CM (both channels) to CAL
   Input coupling (both channels) to GND
   A POSITION to center trace
5. Numbers in parentheses indicate wire color using resistor color code.
   Example: White-Brown-Green is (915).
6. Primary signal paths weighted.

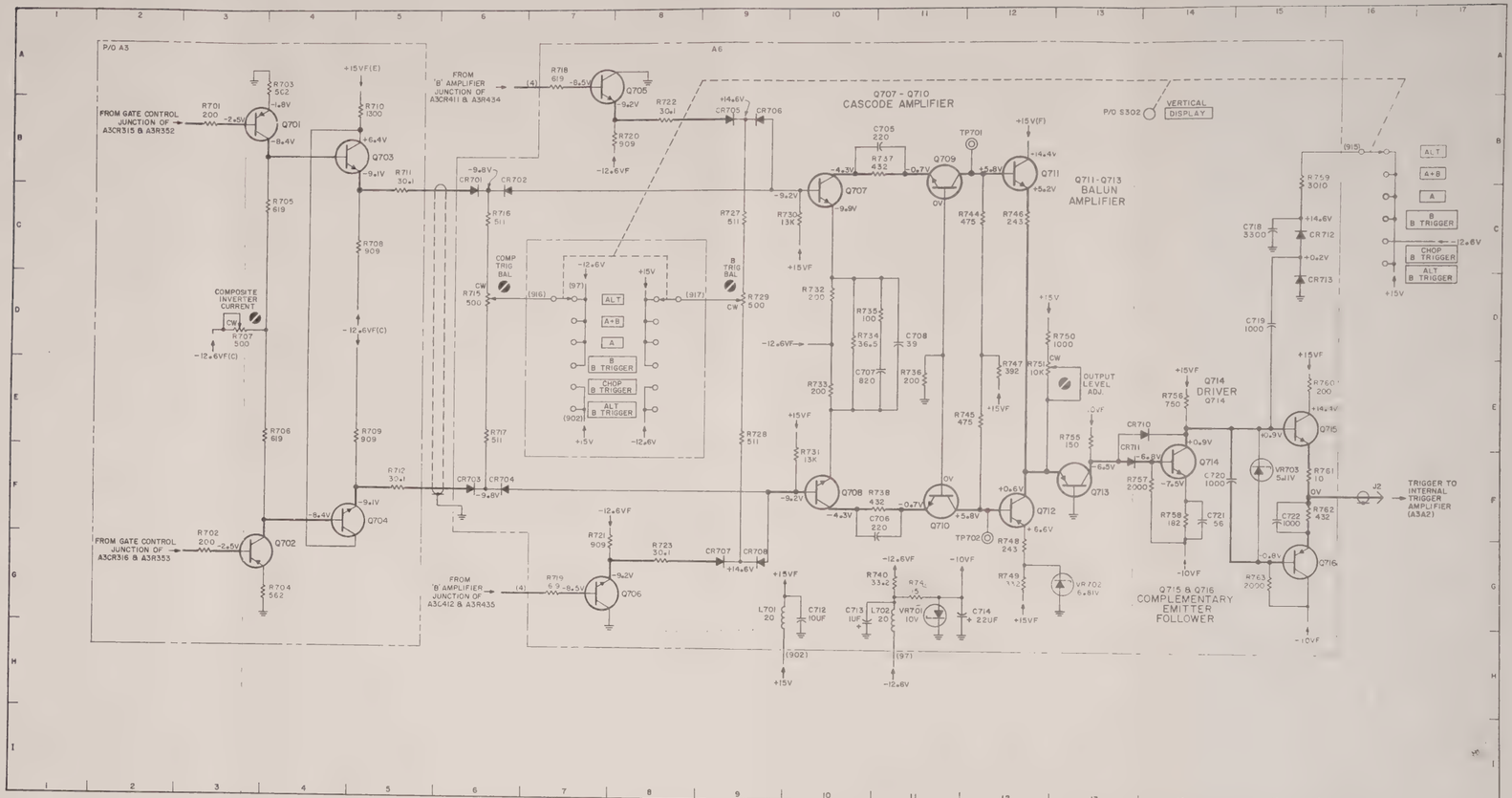


Figure 5-31. Dual Channel Vertical Amplifier Schematic Diagram (Sheet 5 of 5)

PARTS LOCATION INDEX

REF. DESIG.	DRAWING LOCATION	REF. DESIG.	DRAWING LOCATION	REF. DESIG.	DRAWING LOCATION	REF. DESIG.	DRAWING LOCATION
C100	3F	CR115	13F	R104	6B	R137	12E
C101	4A	CR116	14G	R105	4D	R138	12E
C102	4D	CR117	14G	R106	3E	R139	13E
C103	3E	J101	2B	R107	3F	R140	15E
C104	4F	L102	4D	R108	4E	R141	14D
C105	5C	L103	4F	R109	4E	R145	15F
C106	6C	L104	6D	R110	4E	R146	15D
C107	4E	L107	11B	R111	4G	R147	14F
C109	7D	L108	11C	R112	6E	R148	14F
C111	8D	L109	11D	R113	6E	R149	15F
C112	9C	L110	10G	R114	6D	R150	12G
C113	10C	P1	3B	R117	7D	R151	12H
C117	10B	P2	2F	R118	8D	R152	12H
C118	11C	Q101	4E	R119	8C	R153	13G
C119	12D	Q102	4F	R120	8E	R154	14H
C120	13D	Q103	8D	R121	6F	R155	14G
C121	15D	Q104	9E	R122	7F	R156	14G
C122	11G	Q105	10E	R124	7F	S101	5B
C123	12G	Q106	8F	R125	8G	S102	5D
CR103	7E	Q107	11D	R126	9E	S103	9B
CR104	9D	Q108	13D	R127	8G	S104	12F
CR105	10D	Q109	14E	R130	10B	TP101	11D
CR106	11D	Q110	11G	R131	11B	VR100	3E
CR107	9D	Q111	13G	R132	11C	VR101	13E
CR108	9D	Q112	15G	R133	11C	VR102	14E
CR109	9E	R101	4B	R134	13C		
CR110	9E	R102	4C	R135	14C		
CR114	15E	R103	4B	R136	11E		

NOTES:

1. Unless otherwise indicated, electrical values for resistors, coils and capacitors are expressed in ohms, microhenries or picofarads.
2. The letters cw placed adjacent to the appropriate terminal of a potentiometer indicate the maximum clockwise rotation as viewed from the shaft end.
3. All reference designators preceded by A3 unless otherwise noted.
4. Dc voltage measurements taken with ME-243/FQM Electronic Voltmeter (or equivalent). Control settings as follows:
   Horizontal DISPLAY to INT
   SWEEP MODE to AUTO
   Main TRIGGER LEVEL fully cw
   Main trigger source EXT÷10
   Main SLOPE to +
   Main trigger coupling to DC
5. Voltages in parentheses are measured after making initial control settings with exceptions shown below:
   Main TRIGGER LEVEL fully ccw
   SWEEP MODE to SINGLE
6. Numbers in parentheses indicate wire color using resistor color code.
   Example: White-Violet is (97).
7. Primary signal paths weighted.

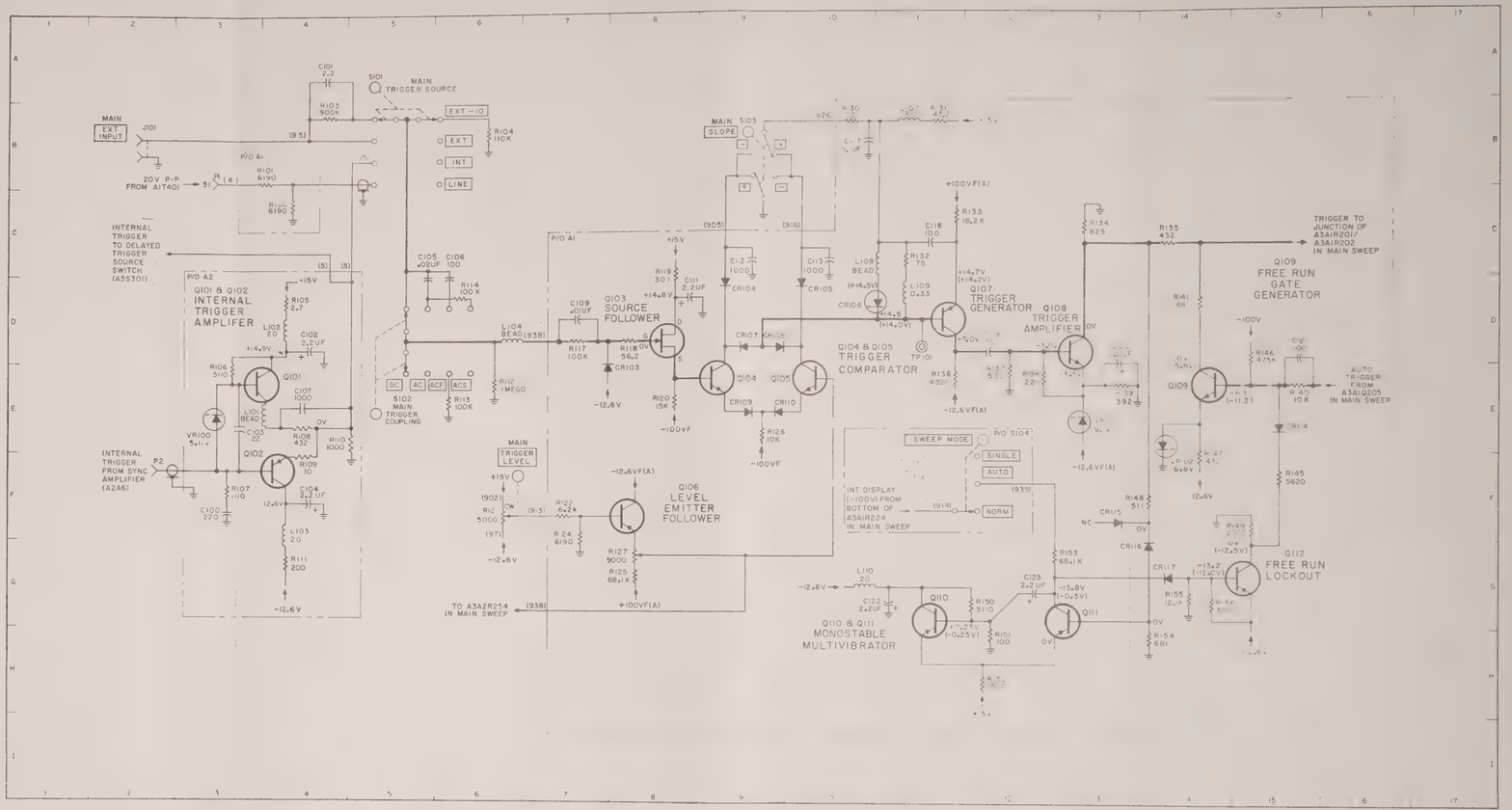


Figure 5-32. Time Base and Delay Generator Schematic Diagram (Sheet 1 of 5)

PARTS LOCATION INDEX

REF. DESIG.	DRAWING LOCATION	REF. DESIG.	DRAWING LOCATION	REF. DESIG.	DRAWING LOCATION	REF. DESIG.	DRAWING LOCATION
C201	5C	CR213	15D	R205	6C	R238	13C
C202	7C	CR214	15E	R206	7C	R239	13C
C203	8D	CR215	10E	R207	7D	R240	14C
C204	5E	CR216	12F	R208	7C	R241	14B
C205	5F	CR217	12F	R209	8B	R245	15B
C206	5G	CR218	13G	R210	8C	R246	15C
C207	5H	CR219	13G	R211	8B	R247	14D
C208	7H	CR220	11G	R215	2E	R248	14D
C209	8F	DS201	2E	R216	2E	R249	15D
C211	12H	L201	8D	R217	2F	R250	15E
C213	11C	L202	6H	R218	2F	R251	15F
C214	13B	L203	12B	R219	2F	R252	15F
C215	13C	P1	5H, 8A	R220	4F	R253	15G
C216	14B	Q201	6C	R221	4F	R254	12H
C217	15C	Q202	8C	R222	5E	R255	12H
C218	15D	Q203	3F	R223	5G	R256	13H
C219	15F	Q204	4F	R224	5G	R257	13H
C220	15F	Q205	6F	R225	7F	S104	10G
CR201	5C	Q206	11D	R226	6F	S201	6H
CR202	6D	Q207	13B	R227	7H	S501	11D
CR203	7C	Q208	14C	R228	8H	TP201	3C
CR204	7D	Q209	15C	R229	7E	TP202	7C
CR205	5F	Q210	14G	R232	10B	TP203	8F
CR206	5F	Q211	14G	R233	10B	TP204	16E
CR207	7E	R201	4C	R234	11C	V201	8H
CR210	9B	R202	5D	R235	11E	VR201	15B
CR211	10B	R203	5C	R236	11E		
CR212	15B	R204	6D	R237	13B		

NOTES:

1. Unless otherwise indicated, electrical values for resistors, coils and capacitors are expressed in ohms, microhenries or picofarads.
2. The letters cw placed adjacent to the appropriate terminal of a potentiometer indicate the maximum clockwise rotation as viewed from the shaft end.
3. All reference designators preceded by A3 unless otherwise noted.
4. Dc voltage measurements taken with ME-243/FQM Electronic Voltmeter (or equivalent). Control settings as follows.
   - Horizontal DISPLAY to INT
   - MAIN VERNIER to CAL
   - Sweep display to MAIN
   - Main TIME/CM to 1 USEC
   - SWEEP MODE to AUTO
   - TP201 grounded
5. Voltages in parentheses are measured with TP201 connected through a 1k ohm resistor to -12.6 vdc.
6. Numbers in parentheses indicate wire color using resistor color code. Example: White-Black-Yellow is (904).
7. Primary signal paths weighted. Feedback paths weighted and dashed.

   Voltages listed for Q207 are typical. Actual voltages vary with the characteristic of the FET.

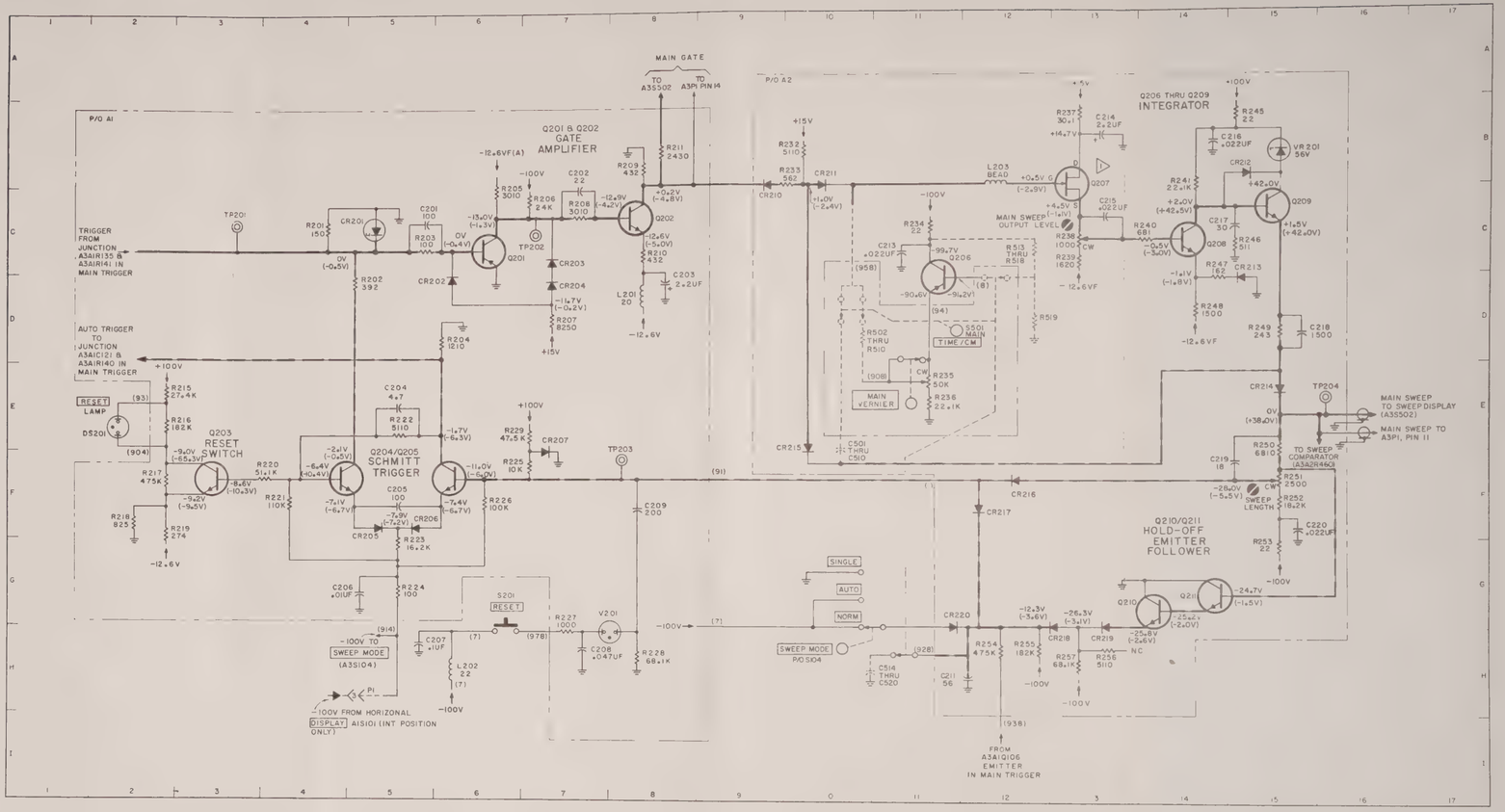


Figure 5-32. Time Base and Delay Generator Schematic Diagram (Sheet 2 of 5)

PARTS LOCATION INDEX

REF. DESIG.	DRAWING LOCATION	REF. DESIG.	DRAWING LOCATION	REF. DESIG.	DRAWING LOCATION	REF. DESIG.	DRAWING LOCATION
C301	3A	CR303	10B	R301	3A	R325	13C
C302	4C	CR304	10D	R302	5B	R326	14C
C303	5C	CR305	9D	R303	6D	R327	11D
C307	7D	CR306	9D	R304	5E	R328	12F
C308	8C	CR307	9E	R305	5C	R329	12D
C310	9F	CR308	9E	R307	7D	R330	13E
C311	9C	CR309	12E	R308	7D	R331	13D
C312	10B	J301	2B	R309	8C	R332	14E
C316	10B	L301	6D	R310	8E	R333	13E
C317	11C	L302	11B	R311	9F	R336	9H
C318	12D	L303	10B	R312	9E	R337	10H
C319	12E	L304	11C	R313	5F	R338	11H
C320	14D	L305	12H	R314	7F	R339	12H
C324	9H	L306	13H	R315	7G	R340	13H
C325	10H	Q301	8D	R317	8G	S301	4B, 4F, 12F
C326	12H	Q302	9D	R318	8G	S302	4D
C327	13H	Q303	10D	R321	10B	S303	9B
C328	14H	Q304	8F	R322	11B	TP301	11D
CR301	7D	Q305	11D	R323	11C	VR301	13E
CR302	9C	Q306	13D	R324	11C		

NOTES:

1. Unless otherwise indicated, electrical values for resistors, coils, and capacitors are expressed in ohms, microhenries or picofarads.
2. The letters cw placed adjacent to the appropriate terminal of a potentiometer indicate the maximum clockwise rotation as viewed from the shaft end.
3. All reference designators preceded by A3 unless otherwise noted.
4. Dc voltage measurements taken with ME-243/FQM Electronic Voltmeter (or equivalent). Control settings as follows:
   Horizontal DISPLAY to INT
   SWEEP MODE to AUTO
   Delayed TRIGGER LEVEL fully cw
   Delayed SLOPE to +
   Delayed trigger coupling to DC
5. Voltages in parentheses are measured after making initial control settings with exception shown below:
   Delayed TRIGGER LEVEL fully ccw
6. Numbers in parentheses indicate wire color using resistor color code.
   Example: White-Brown-Red is (912).
7. Primary signal paths weighted. Feedback paths weighted and dashed.

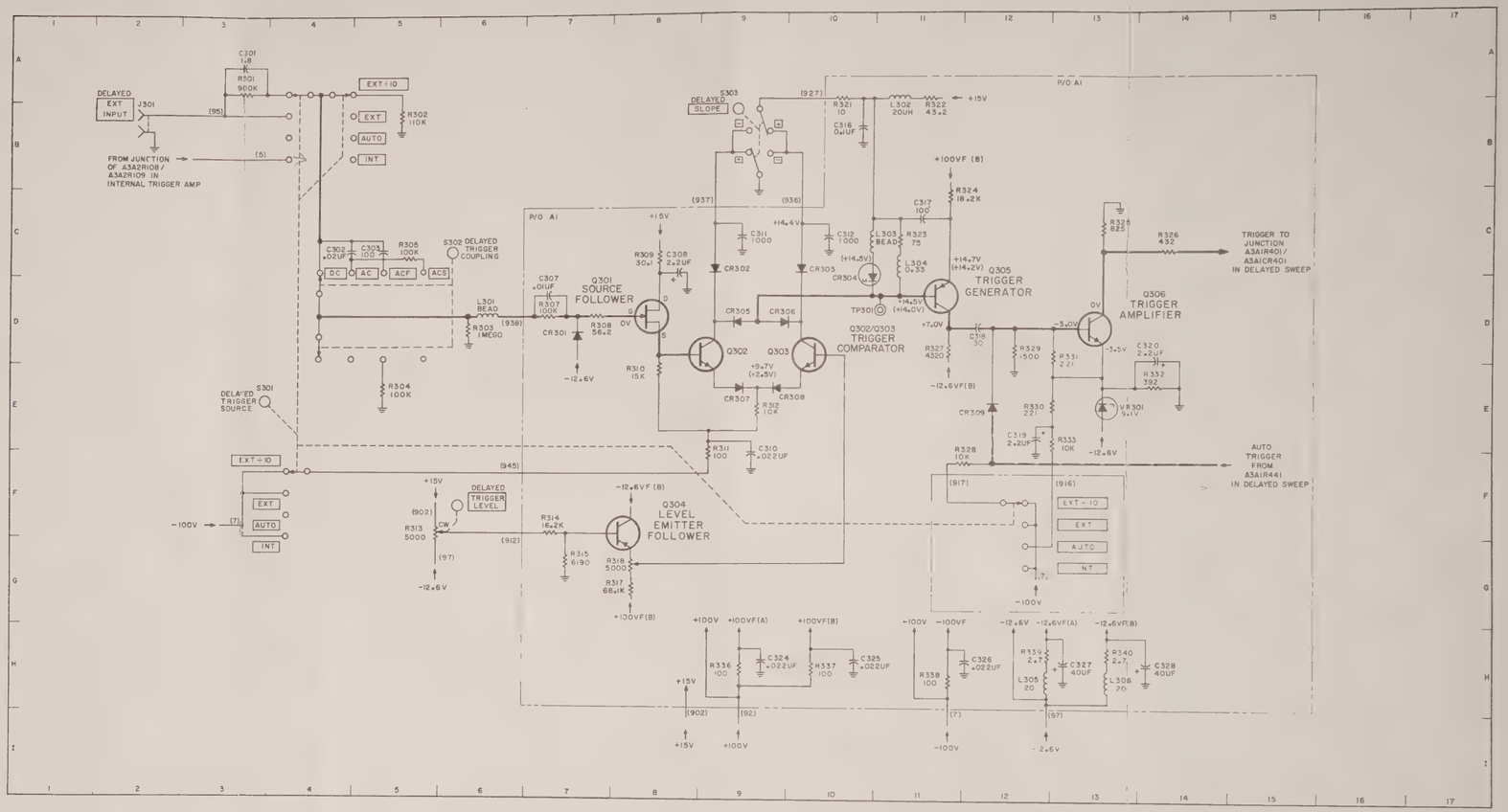


Figure 5-32. Time Base and Delay Generator Schematic Diagram (Sheet 3 of 5)

PARTS LOCATION INDEX

REF. DESIG.	DRAWING LOCATION	REF. DESIG.	DRAWING LOCATION	REF. DESIG.	DRAWING LOCATION	REF. DESIG.	DRAWING LOCATION
C401	4C	CR413	9D	R407	6B	R448	4F
C402	6C	CR414	14B	R408	6B	R449	7E
C403	10C	CR415	15C	R409	6C	R450	7F
C404	13B	CR416	15D	R410	7B	R454	7H
C405	14A	CR420	3F	R411	7B	R455	7H
C406	15B	CR421	4F	R412	7C	R456	7I
C407	15C	CR422	8I	R413	7D	R457	8G
C408	14E	CR423	9F	R417	9C	R458	8G
C409	15F	CR424	10G	R418	9C	R459	8H
C413	2F	CR425	11G	R419	10B	R460	9G
C414	2F	J401	6I	R420	10D	R461	10H
C415	3G	L402	11B	R421	10D	R462	10 I
C416	4E	P1	7A, 16E	R422	13B	R463	11H
C417	4F	Q401	5C	R423	13C	R464	11H
C418	5F	Q402	6C	R424	13B	R468	12F
C419	7F	Q403	3F	R425	14B	R469	12F
C420	7F	Q404	4F	R429	14A	R470	12F
C421	7H	Q405	10C	R430	15C	R471	13G
C422	8H	Q406	13B	R431	14C	R472	12H
C423	10F	Q407	14B	R432	14C	R473	12H
C424	10 I	Q408	15B	R433	15C	R474	13H
C425	12G	Q409	7H	R434	15E	S503	11D
C426	12G	Q410	8G	R435	15E	TP401	2C
CR401	3C	Q411	9G	R436	15F	TP402	5C
CR402	4D	Q412	11G	R437	15F	TP403	5F
CR403	5C	Q413	10H	R441	2F	TP404	15D
CR404	5D	R401	3C	R442	3F	VR401	10F
CR405	6B	R402	3D	R443	4E	VR402	10F
CR406	7C	R403	4C	R444	4G	VR403	15B
CR410	8C	R404	5C	R445	4G		
CR411	9B	R405	5D	R446	4E		
CR412	10E	R406	5C	R447	5F		

NOTES:

1. Unless otherwise indicated, electrical values for resistors, coils and capacitors are expressed in ohms, microhenries or picofarads.
2. The letters cw placed adjacent to the appropriate terminal of a potentiometer indicate the maximum clockwise rotation as viewed from the shaft end.
3. All reference designators preceded by A3.
4. Dc voltage measurements taken with ME-243/FQM Electronic Voltmeter (or equivalent). Control settings as follows:
   Horizontal DISPLAY to INT
   Sweep display to MAIN
   Delayed TIME/CM to .2 SEC
   DELAYED VERNIER to CAL
   CM DELAY to 4.00
5. Ground TP201 (main sweep) and TP401 when taking voltage measurements in sweep comparator circuits.
6. Ground only TP401 when taking voltage measurements in Gate Amplifier, Gate Inverter, Integrator and Emitter Follower circuits.
7. Voltages in parentheses are measured with TP401 connected through a 1k ohm resistor to -12.6 vdc.
8. Numbers in parentheses indicate wire color using resistor color code. Example: White-Green-Gray is (958).
9. Primary signal paths weighted. Feedback paths weighted and dashed.

1 Voltages listed for Q406 and Q412 are typical. Actual voltages vary with the characteristics of the FET.

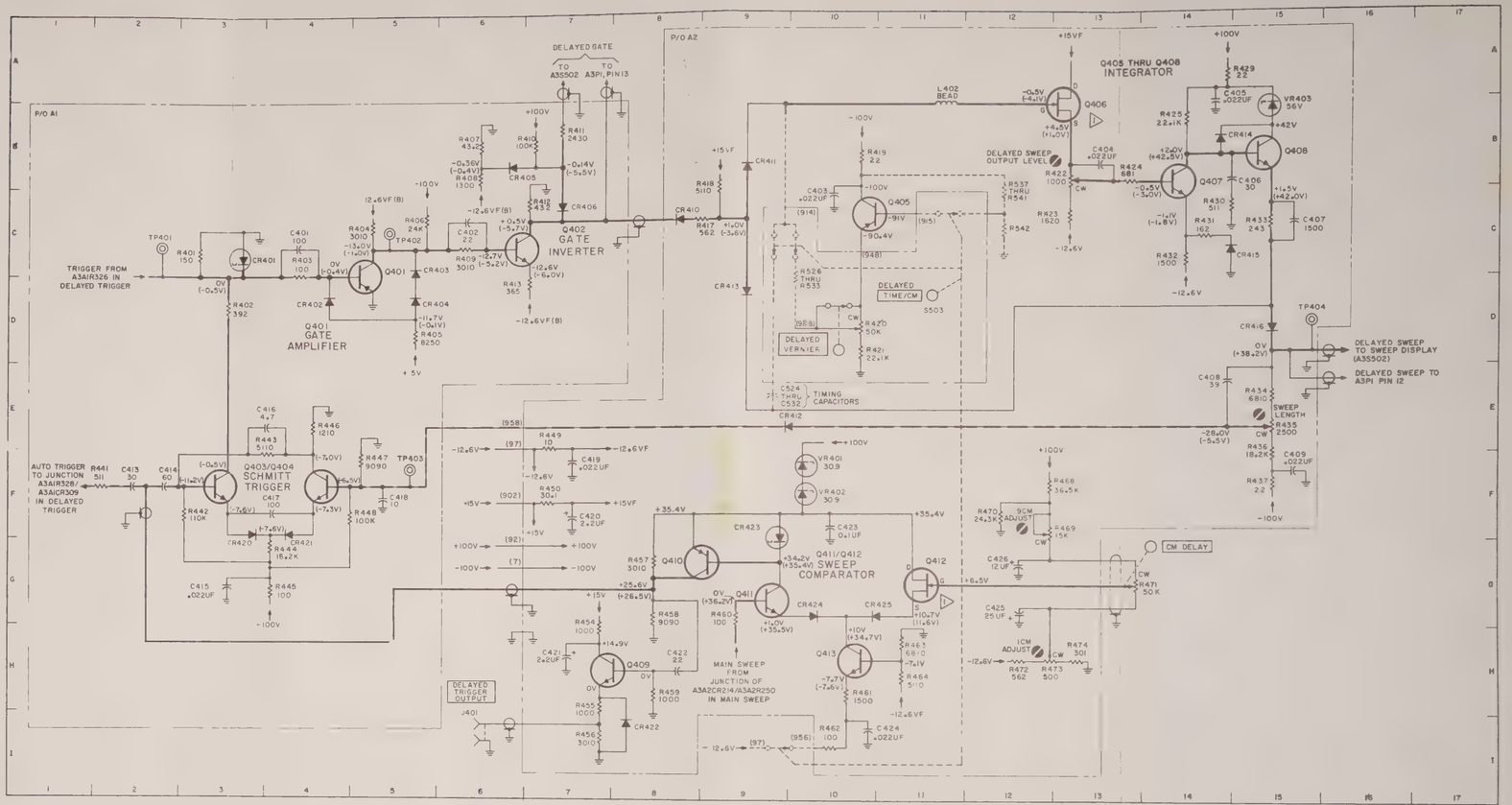


Figure 5-32. Time Base and Delay Generator Schematic Diagram (Sheet 4 of 5)

PARTS LOCATION INDEX

REF. DESIG.	DRAWING LOCATION
C501	2C
C502	2D
C503	2E
C504	2F
C505	2F
C506	2G
C507	2G
C508	2G
C509	2H
C510	2H
C514	8C
C515	8D
C516	8E
C517	8F
C518	8F
C519	8G
C520	8H
C524	11C
C525	11D
C526	11E

REF. DESIG.	DRAWING LOCATION
C527	11E
C528	11F
C529	11F
C530	11F
C531	11G
C532	11G
CR501 through CR502	9D
R500	4B
R502	4C
R503	4C
R504	4C
R505	4F
R506	5G
R507	5G
R508	4G
R509	4G
R510	4H
R513	6C
R514	6E

REF. DESIG.	DRAWING LOCATION
R515	6E
R516	6F
R517	6F
R518	6G
R519	6G
R520	10B
R521	9D
R522	9F
R523	10E
R524	9F
R525	9F
R526	13C
R527	14C
R528	13E
R529	14F
R530	14F
R531	13F
R532	14F
R533	14G
R537	15D

REF. DESIG.	DRAWING LOCATION
R538	15D
R539	15E
R540	15E
R541	15F
R542	15F
S501 through S502	3C-3H through 9C-9H
S503 through CR502	10C-10H through 17C-17G

NOTES:

1. Unless otherwise indicated, electrical values for resistors and capacitors are expressed in ohms or picofarads.
2. The letters cw placed adjacent to the appropriate terminal of a potentiometer indicate the maximum clockwise rotation as viewed from the shaft end.
3. All reference designators prefixed by A3.
4. Numbers in parentheses indicate wire color using resistor color code. Example: White-Yellow-Green is (945).

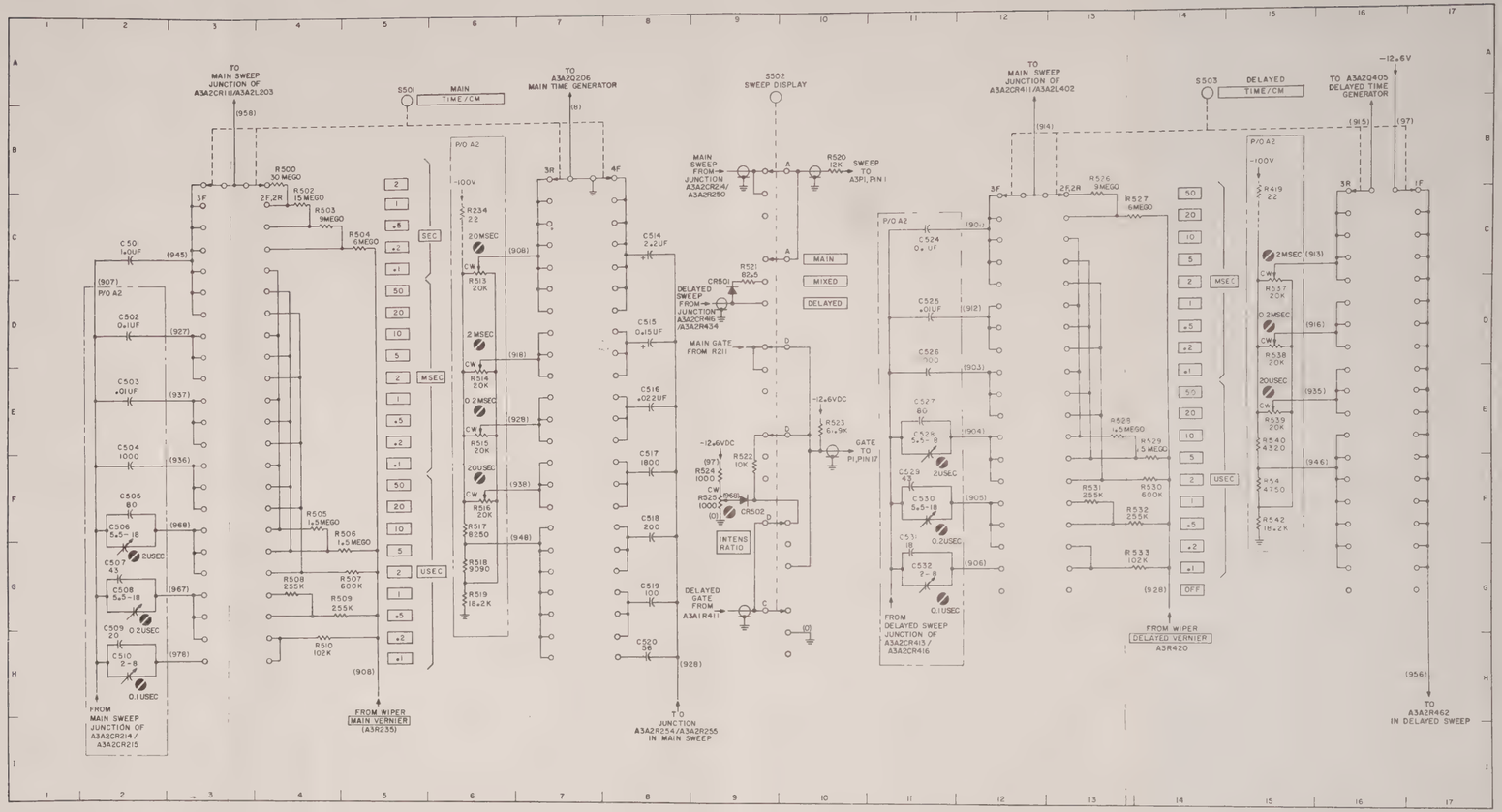


Figure 5-32. Time Base and Delay Generator Schematic Diagram (Sheet 5 of 5)

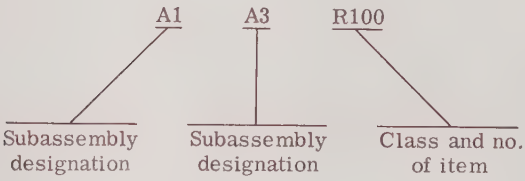
SECTION 6

PARTS LIST

6-1. INTRODUCTION.

a. REFERENCE DESIGNATIONS. - The unit numbering method of assigning reference designations has been used to identify assemblies and subassemblies. The block numbering system has been used to identify detail parts. This method has been expanded as much as necessary to adequately cover the various degrees of subdivision of the equipment. An example of this numbering method is illustrated by the following:

EXAMPLE:



Read as: First (100) resistor (R) of third (3) subassembly (A) of first (1) subassembly (A).

b. REFERENCE DESIGNATION PREFIX. - Partial reference designations are used on the illustrations. The parital reference designations consist of the class letter(s) and the identifying item number. The complete reference designations may be obtained by placing the proper subassembly prefix(es) before the partial reference designations. The main subassembly prefix is identified in the figure title or notes accompanying the illustration. Secondary subassemblies are enclosed in broken lines with the subasembly prefix listed in the upper left-hand corner of the box.

6-2. MAINTENANCE PARTS LIST.

Table 6-1 list all subassemblies and their maintenance parts. The subassemblies are listed in numerical sequence. Maintenance parts for each subassembly are listed alphabetically-numerically by class of part. Table 6-1 provides the following information: (1) The complete reference designation of each subassembly or part; (2) noun name and brief description; (3) identification of the illustration which pictorially locates the part.

Printed circuit boards, assembly boards, modules, etc., are listed first as individual items in the maintenance parts list. The individual circuit board, assembly board, module etc., is then broken down by components into separate parts listings. When there is a redundency of components on a subsequent subassembly, reference is made to the previously listed description.

6-3. LIST OF MANUFACTURERS.

Table 6-2 lists the manufacturers of parts used in the equipment. The table includes the manufacturer's code used in table 6-1 to allow identification of the manufacturers.

6-4. STOCK NUMBER IDENTIFICATION.

Allowance Parts List (APL) issued by the Electronics Supply Office (ESO) inculdes Federal Stock Numbers and Source Maintenance and Recoverability Codes. Therefore, reference should be made to the APL prepared for the equipment for stock numbering information.

TABLE 6-1. MAINTENANCE PARTS LIST

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG. NO.
		OSCILLOSCOPE: MIL type AN/USM-281.	
A1		OSCILLOSCOPE ASSEMBLY: MIL type OS-189(P)/USM-281.	5-10
A1A1		CIRCUIT BOARD, CALIBRATOR, GATE, AND HIGH VOLTAGE CONTROL: Printed circuit board w/all components assembled for operation; mfr 28480, P/N 00180-66511.	5-13
A1A1C100		Not Used.	
A1A1C101		Not Used.	
A1A1C102		CAPACITOR, FIXED, MYLAR: 0.01 uf ±5%, 200 vdcw; mfr 56289, P/N 192P10352 PTS.	5-13
A1A1C103		CAPACITOR, FIXED, MYLAR: 0.022 uf ±10%; mfr 56289, P/N 192P22392 PTS.	5-13
A1A1C104		CAPACITOR: Same as A1A1C103.	5-13
A1A1C105		CAPACITOR: Same as A1A1C103.	5-13
A1A1C106		CAPACITOR: Same as A1A1C103.	5-13
A1A1C107 to A1A1C109		Not Used.	
A1A1C110		CAPACITOR, VARIABLE, POLYSTYRENE: 0.7 to 3 pf, 350 vdcw; mfr 72982, P/N 535-009-4R.	5-13
A1A1C111		CAPACITOR: MIL type CC20CJ3R3C	5-13
A1A1C112		CAPACITOR: MIL type CM06FC202G03	5-13
A1A1C113		CAPACITOR, VARIABLE, TEFLON: 0.2 to 1.5 pf, 600 vdcw; mfr 72982, P/N 530-000.	5-13
A1A1C114		CAPACITOR: Same as A1A1C103.	5-13
A1A1C115		CAPACITOR, FIXED, ELECTROLYTIC: 100 uf, 12 vdcw; mfr 56289, P/N 30D107G012CC2DSM.	5-13
A1A1C116		CAPACITOR, FIXED, CERAMIC: 20 pf, 100 vdcw; mfr 56289, P/N 53C47.	5-13
A1A1C117 to A1A1C119		Not Used.	
A1A1C120		CAPACITOR, FIXED, TANTALUM: 2.2 uf ±20%, 20 vdcw; MIL type CS13BE225M.	5-13
A1A1C121		CAPACITOR, FIXED, MICA: 5825 pf ±2%, 300 vdcw; mfr 00853, P/N RDM20F5825QG3S.	5-13
A1A1C122		CAPACITOR: Same as A1A1C121.	5-13
A1A1C123		CAPACITOR, FIXED, ELECTROLYTIC: 10 uf -10% +100%, 150 vdcw; mfr 56289, P/N 30D106F150DD2DSM.	5-13
A1A1C300		Not Used.	
A1A1C301		CAPACITOR, FIXED, ELECTROLYTIC: 20 uf, 25 vdcw; mfr 56289, P/N 40D206G025DC6DST.	5-13
A1A1C302		CAPACITOR, FIXED, CERAMIC: 4500 pf, 3500 vdcw; mfr 28480, P/N 0160-2486.	5-13
A1A1C303		CAPACITOR, FIXED, MYLAR: 0.1 uf ±5%, 200 vdcw; mfr 56289, P/N 192P10452PTS.	5-13
A1A1C304 to A1A1C309		Not Used.	
A1A1C310		CAPACITOR, FIXED, CERAMIC: 0.01 uf, 5000 vdcw; mfr 71590, P/N DA938-000J.	5-13
A1A1C311		CAPACITOR, FIXED, CERAMIC: 0.01 uf, 5000 vdcw; mfr 28480, P/N 0160-2320.	5-13
A1A1C312 to A1A1C315		Not Used.	
A1A1C316		CAPACITOR: Same as A1A1C310.	5-13
A1A1C317		CAPACITOR: Same as A1A1C311.	5-13
A1A1CR100		Not Used.	

TABLE 6-1. (Continued)

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG. NO.
A1A1CR101		DIODE, SILICON: Mfr 07263, P/N FD7018.	5-13
A1A1CR102		DIODE, SILICON: JAN 1N914.	5-13
A1A1CR103		DIODE: Same as A1A1CR102.	5-13
A1A1CR104		DIODE: Same as A1A1CR102.	5-13
A1A1CR105 to A1A1CR107			
A1A1CR108		DIODE: Same as A1A1CR102.	5-13
A1A1CR109		DIODE, SILICON: Mfr 04713, P/N SR1358-10.	5-13
A1A1CR110		DIODE: Same as A1A1CR109.	5-13
A1A1CR111		DIODE: Same as A1A1CR102.	5-13
A1A1CR112		DIODE, SILICON: Mfr 04713, P/N SR1356.	5-13
A1A1CR113		DIODE: Same as A1A1CR112.	5-13
A1A1CR114		Not Used.	
A1A1CR115		DIODE, SILICON: Mfr 07263, P/N FD2225.	5-13
A1A1CR116		DIODE: Same as A1A1CR115.	5-13
A1A1CR117		DIODE: Same as A1A1CR115.	5-13
A1A1L100		Not Used.	
A1A1L101		Not Used.	
A1A1L102		INDUCTOR, FIXED: 20 uh ±10%; mfr 99848, P/N H51074020.	5-13
A1A1L103 to A1A1L104		Not Used.	
A1A1L105		INDUCTOR: Same as A1A1L102.	5-13
A1A1Q100		Not Used.	
A1A1Q101		TRANSISTOR, SILICON, NPN: Mfr 04713, P/N SS2188.	5-13
A1A1Q102		TRANSISTOR: Same as A1A1Q101.	5-13
A1A1Q103		TRANSISTOR, SILICON, PNP: Mfr 04713, P/N SS2123.	5-13
A1A1Q104		TRANSISTOR, SILICON, NPN: MIL type 2N3119.	5-13
A1A1Q105		TRANSISTOR, SILICON, PNP: Mfr 04713, P/N SS2111.	5-13
A1A1Q106		TRANSISTOR, SILICON, NPN: MIL type 2N3440.	5-13
A1A1Q107		TRANSISTOR: Same as A1A1Q106.	5-13
A1A1Q300		Not Used.	
A1A1Q301		TRANSISTOR, SILICON, NPN: Mfr 07263, P/N S3620.	5-13
A1A1Q302		TRANSISTOR, SILICON, NPN: Mfr 01295, P/N SK1124.	5-13
A1A1Q303		TRANSISTOR, SILICON, NPN: MIL type 2N3053.	5-13
A1A1R100		Not Used.	
A1A1R101		Not Used.	
A1A1R102		RESISTOR: MIL type RN60C2000F.	5-13
A1A1R103		RESISTOR: Same as A1A1R102.	5-13
A1A1R104		RESISTOR: MIL type RN60C1000F.	5-13
A1A1R105		RESISTOR: MIL type RN60C5112F.	5-13
A1A1R106		Not Used.	
A1A1R107		RESISTOR: MIL type RN60C2741F.	5-13
A1A1R108 to A1A1R110		Not Used.	
A1A1R111		RESISTOR: Same as A1A1R104.	5-13
A1A1R112		RESISTOR: Same as A1A1R104.	5-13
A1A1R113		RESISTOR: Same as A1A1R104.	5-13
A1A1R114		RESISTOR: MIL type RN60C6191F.	5-13
A1A1R115		RESISTOR: MIL type RN60C3920F.	5-13
A1A1R116		RESISTOR: MIL type RN60C6812F.	5-13
A1A1R117		RESISTOR: MIL type RN65C5620F.	5-13
A1A1R118		RESISTOR: Same as A1A1R102.	5-13
A1A1R119		RESISTOR: MIL type RN65C1302F.	5-13

TABLE 6-1. (Continued)

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG. NO.
A1A1R120		RESISTOR: MIL type RN60C1503F.	5-13
A1A1R121		RESISTOR: Same as A1A1R119.	5-13
A1A1R122 to A1A1R124		Not Used.	
A1A1R125		RESISTOR: MIL type RN60C1001F.	5-13
A1A1R126		RESISTOR: MIL type RN65C2002F.	5-13
A1A1R127		RESISTOR: MIL type RN60C5110F.	5-13
A1A1R128		RESISTOR: MIL type RN60C8251F.	5-13
A1A1R129		RESISTOR: MIL type RN60C5111F.	5-13
A1A1R130		RESISTOR: MIL type RN60C3651F.	5-13
A1A1R131		RESISTOR: MIL type RN60C2001F.	5-13
A1A1R132		RESISTOR: MIL type RN60C8250F.	5-13
A1A1R133		RESISTOR, FIXED, METAL OXIDE: 68k ohms ±5%, 1w; mfr 14674, P/N C32-6802J.	5-13
A1A1R134 to A1A1R135		Not Used.	
A1A1R136		RESISTOR: Same as A1A1R126.	5-13
A1A1R137		RESISTOR: MIL type RN60C1303F.	5-13
A1A1R138		RESISTOR: Same as A1A1R137.	5-13
A1A1R139		RESISTOR: MIL type RC07GF2R7J.	5-13
A1A1R140		RESISTOR: Same as A1A1R131.	5-13
A1A1R141		RESISTOR: Same as A1A1R102.	5-13
A1A1R142		RESISTOR: Same as A1A1R126.	5-13
A1A1R143		RESISTOR, FIXED, METAL FILM: 50 ohms ±0.1%, 1/8w; mfr 19701, P/N MF5C-C50R0B.	5-13
A1A1R144		RESISTOR, FIXED, METAL FILM: 1.95k ohms ±0.1%, 1/8w; mfr 19701, P/N MF5C-C1951B.	5-13
A1A1R145		RESISTOR, FIXED, METAL FILM: 17.82k ohms ±0.1%, 1/2w; mfr 28480, P/N 0698-5421.	5-13
A1A1R300		Not Used.	
A1A1R301		RESISTOR: Same as A1A1R139.	5-13
A1A1R302		RESISTOR, VARIABLE, METAL FILM: 100k ohms ±20%; mfr 28480, P/N 2100-0943.	5-13
A1A1R303		RESISTOR: MIL type RN65D9503F.	5-13
A1A1R304		RESISTOR: MIL type RN60C1002F.	5-13
A1A1R305		RESISTOR, FIXED, METAL FILM: 30 megohms ±2%, 1/2w; mfr 03888, P/N HV2000N5.	5-13
A1A1R306 to A1A1R312		Not Used.	
A1A1R313		RESISTOR: Same as A1A1R304.	5-13
A1A1R314		RESISTOR: Same as A1A1R129.	5-13
A1A1R315		RESISTOR, FIXED, CARBON FILM: 2.49 megohms ±1%, 1/2w; mfr 28480, P/N 0698-3553.	5-13
A1A1R316		RESISTOR: Same as A1A1R131.	5-13
A1A1R317		RESISTOR: Same as A1A1R125.	5-13
A1A1R318		RESISTOR: MIL type RN60C1003F.	5-13
A1A1R319		RESISTOR: Same as A1A1R104.	5-13
A1A1R320		RESISTOR: MIL type RN70C5110F.	5-13
A1A1R321		RESISTOR: Same as A1A1R318.	5-13
A1A1R322 to A1A1R327		Not Used.	
A1A1R328		RESISTOR: MIL type RC07GF105J.	5-13
A1A1R329		Not Used.	

TABLE 6-1. (Continued)

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG. NO.
A1A1R330		RESISTOR: MIL type RN60C4322F.	5-13
A1A1R331		RESISTOR: MIL type RN60C6192F.	5-13
A1A1R332		RESISTOR: Same as A1A1R330.	5-13
A1A1R333		RESISTOR: Same as A1A1R331.	5-13
A1A1R334 to A1A1R340		Not Used.	
A1A1R341		RESISTOR: MIL type RC07GF153J.	5-13
A1A1R342		Not Used.	
A1A1R343		RESISTOR, FIXED, COMPOSITION: 8.25 megohms ±5%, 1w; mfr 28480, P/N 0698-5677.	5-13
A1A1R344		Not Used.	
A1A1R345		RESISTOR, FIXED, COMPOSITION: 16.25 megohms ±5%, 1w; mfr 28480, P/N 0698-5678.	5-13
A1A1R346		Not Used.	
A1A1R347		Not Used.	
A1A1R348		RESISTOR, VARIABLE, METAL FILM: 50k ohms ±30%; mfr 73138, P/N 62P-R50K.	5-13
A1A1R349		RESISTOR: MIL type RN60C3322F.	5-13
A1A1R350		Not Used.	
A1A1R351		RESISTOR: Same as A1A1R125.	5-13
A1A1R352		RESISTOR: Same as A1A1R125.	5-13
A1A1R353		RESISTOR: Same as A1A1R331.	5-13
A1A1R354		RESISTOR: Same as A1A1R330.	5-13
A1A1TP300		Not Used.	
A1A1TP301		JACK, TEST, FEMALE: Mfr 98291, P/N SKT400.	5-13
A1A1V300		Not Used.	
A1A1V301		LAMP, NEON: Mfr 24455, P/N NE2E1.	5-13
A1A1V302		LAMP: Same as A1A1V301.	5-13
A1A1VR300		Not Used.	
A1A1VR301		DIODE, ZENER: 7.2v, 400 mw; mfr 01281, P/N PS18247B.	5-13
A1A1VR302		DIODE, ZENER: 10v, 400 mw; mfr 01281, P/N PS18260A.	5-13
A1A2		CIRCUIT BOARD, MAIN AND DELAYED SWEEP AND GATE OUTPUT AMPLIFIER: Printed circuit board w/all components assembled for operation; mfr 28480, P/N 00180-66516.	5-14
A1A2C100 to A1A2C126		Not Used.	
A1A2C127		CAPACITOR: Same as A1A1C120.	5-14
A1A2C128		CAPACITOR: Same as A1A1C120.	5-14
A1A2L100 to A1A2L106		Not Used.	
A1A2L107		INDUCTOR: Same as A1A1L102.	5-14
A1A2L108		INDUCTOR: Same as A1A1L102.	5-14
A1A2Q100 to A1A2Q107		Not Used.	
A1A2Q108		TRANSISTOR: Same as A1A1Q302.	5-14
A1A2Q109		TRANSISTOR: Same as A1A1Q302.	5-14
A1A2Q110		TRANSISTOR, SILICON, PNP: MIL type 2N3638	5-14
A1A2Q111		TRANSISTOR: Same as A1A2Q110	5-14
A1A2R100 to A1A2R148		Not Used.	

TABLE 6-1. (Continued)

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG. NO.
A1A2R149		RESISTOR: MIL type RN60C2432F.	5-14
A1A2R150		RESISTOR: Same as A1A1R129..	5-14
A1A2R151		RESISTOR: MIL type RN60C4321F.	5-14
A1A2R152		RESISTOR: Same as A1A2R149.	5-14
A1A2R153		RESISTOR: Same as A1A1R129.	5-14
A1A2R154		RESISTOR: Same as A1A2R151.	5-14
A1A2R155		RESISTOR: MIL type RN60C2431F.	5-14
A1A2R156		RESISTOR: Same as A1A1R131.	5-14
A1A2R157		RESISTOR: Same as A1A1R129.	5-14
A1A2R158		RESISTOR: Same as A1A2R155.	5-14
A1A2R159		RESISTOR: Same as A1A1R131.	5-14
A1A2R160		RESISTOR: Same as A1A1R129.	5-14
A1A2R161		RESISTOR: Same as A1A1R139.	5-14
A1A2R162		RESISTOR: Same as A1A1R139.	5-14
A1A3		CIRCUIT BOARD, HORIZONTAL AMPLIFIER: Printed circuit board w/all components assembled for operation; mfr 28480, P/N 00180-66510.	5-15
A1A3C200		Not Used.	
A1A3C201		Not Used.	
A1A3C202		CAPACITOR, FIXED, CERAMIC: 4700 pf -20% +100%, 500 vdcw; mfr 72982, P/N 851-000X5U0-472Z.	5-15
A1A3C203		CAPACITOR, VARIABLE, MICA: 16 to 150 pf, 175 vdcw; mfr 28480, P/N 0131-0004.	5-15
A1A3C204		CAPACITOR: MIL type CM05F361F03.	5-15
A1A3C205		CAPACITOR: Same as A1A1C103.	5-15
A1A3C206		CAPACITOR: Same as A1A1C103.	5-15
A1A3C207 to A1A3C209		Not Used.	
A1A3C210		CAPACITOR, VARIABLE, GLASS: 0.7 to 3 pf, 350 vdcw; mfr 72982, P/N 535-033-4R.	5-15
A1A3C211		CAPACITOR: Same as A1A1C103.	5-15
A1A3C212		CAPACITOR, FIXED, MYLAR: 0.047 uf ±10%, 200 vdcw; mfr 56289, P/N 192P47392PTS.	5-15
A1A3C213		CAPACITOR: Same as A1A3C210.	5-15
A1A3C214		CAPACITOR: MIL type CC20CKR75C.	5-15
A1A3C215 to A1A3C217		Not Used.	
A1A3C218		CAPACITOR: Same as A1A1C103.	5-15
A1A3C219		CAPACITOR: Same as A1A1C103.	5-15
A1A3C220		CAPACITOR: MIL type CS13BE225K.	5-15
A1A3C221		CAPACITOR: Same as A1A3C220.	5-15
A1A3C222		CAPACITOR: Same as A1A1C103.	5-15
A1A3C223 to A1A3C225		Not Used.	
A1A3C226		CAPACITOR: Same as A1A3C220.	5-15
A1A3C227		CAPACITOR: Same as A1A3C220.	5-15
A1A3C228		CAPACITOR: MIL type CSR13G154KM.	5-15
A1A3C229		CAPACITOR: Same as A1A3C210.	5-15
A1A3C230		CAPACITOR: Same as A1A1C103.	5-15
A1A3C231		CAPACITOR: Same as A1A3C212.	5-15
A1A3CR200		Not Used.	

TABLE 6-1. (Continued)

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG. NO.
A1A3CR201		DIODE: Same as A1A1CR115.	5-15
A1A3CR202		DIODE, SILICON: Mfr 28480, P/N 5080-0464.	5-15
A1A3CR203		DIODE: Same as A1A1CR102.	5-15
A1A3CR204		DIODE: Same as A1A3CR202.	5-15
A1A3CR205		DIODE: Same as A1A1CR102.	5-15
A1A3CR206		DIODE: Same as A1A1CR102.	5-15
A1A3CR207		DIODE: Same as A1A3CR202.	5-15
A1A3CR208		DIODE: Same as A1A3CR202.	5-15
A1A3CR209		DIODE: Same as A1A1CR102.	5-15
A1A3L200		INDUCTOR: Same as A1A1L102.	5-15
A1A3L201		INDUCTOR: Same as A1A1L102.	5-15
A1A3L202		INDUCTOR: Same as A1A1L102.	5-15
A1A3L203		INDUCTOR, BEAD, FERRITE: Mfr 02114, P/N 56-590-65/4A.	5-15
A1A3Q200		Not Used.	
A1A3Q201		TRANSISTOR, SILICON, FIELD-EFFECT, N CHANNEL: Mfr 05397, P/N F1151.	5-15
A1A3Q202		TRANSISTOR, SILICON, NPN: Mfr 01295, P/N SM6924.	5-15
A1A3Q203		TRANSISTOR, GERMANIUM, PNP: MIL type 2N2635.	5-15
A1A3Q204		TRANSISTOR: Same as A1A1Q101.	5-15
A1A3Q205		TRANSISTOR: Same as A1A1Q302.	5-15
A1A3Q206		TRANSISTOR: Same as A1A1Q101.	5-15
A1A3Q207		TRANSISTOR: Same as A1A1Q101.	5-15
A1A3Q208		TRANSISTOR: Same as A1A1Q105.	5-15
A1A3Q209		TRANSISTOR: Same as A1A1Q104.	5-15
A1A3Q210		TRANSISTOR: Same as A1A1Q103.	5-15
A1A3Q211		TRANSISTOR: Same as A1A1Q105.	5-15
A1A3Q212		TRANSISTOR: Same as A1A1Q104.	5-15
A1A3Q213		TRANSISTOR: Same as A1A1Q103.	5-15
A1A3R200		Not Used.	
A1A3R201		RESISTOR: Same as A1A1R318.	5-15
A1A3R202		RESISTOR: MIL type RN65C1004F.	5-15
A1A3R203		RESISTOR: Same as A1A1R104.	5-15
A1A3R204		RESISTOR: MIL type RN70C1822F.	5-15
A1A3R205		RESISTOR: MIL type RN60C2210F.	5-15
A1A3R206		RESISTOR: MIL type RN70C2742F.	5-15
A1A3R207		RESISTOR, VARIABLE, COMPOSITION: 50k ohms ±20%, 1/5w; mfr 28480, P/N 2100-1418.	5-15
A1A3R208		RESISTOR: MIL type RN60C7501F.	5-15
A1A3R209		RESISTOR, FIXED, METAL FILM: 3874 ohms ±0.1%, 1/8w; mfr 28480, P/N 0698-5420.	5-15
A1A3R210		RESISTOR: MIL type RN60C8252F.	5-15
A1A3R211 to A1A3R214		Not Used.	
A1A3R215		RESISTOR: Same as A1A1R128.	5-15
A1A3R216		RESISTOR: MIL type RN65C6813F.	5-15
A1A3R217		RESISTOR: Same as A1A1R104.	5-15
A1A3R218		Not Used.	
A1A3R219		RESISTOR: Same as A1A1R331.	5-15
A1A3R220		RESISTOR: Same as A1A1R104.	5-15
A1A3R221		Not Used.	
A1A3R222		RESISTOR: Same as A1A1R131.	5-15
A1A3R223		RESISTOR: MIL type RN65C3322F.	5-15
A1A3R224		Not Used.	
A1A3R225		RESISTOR: MIL type RN65C2431F.	5-15

TABLE 6-1. (Continued)

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG. NO.
A1A3R226 to A1A3R228		Not Used.	
A1A3R229		RESISTOR: Same as A1A1R107.	5-15
A1A3R230		RESISTOR: MIL type RN60C1102F.	5-15
A1A3R231		RESISTOR: Same as A1A1R130.	5-15
A1A3R232		RESISTOR: MIL type RN65C1501F.	5-15
A1A3R233		Not Used.	
A1A3R234		RESISTOR: MIL type RN70C2212F.	5-15
A1A3R235		RESISTOR: MIL type RN60C3920F.	5-15
A1A3R236		Not Used.	
A1A3R237		RESISTOR: Same as A1A1R102.	5-15
A1A3R238		RESISTOR: MIL type RN70C1212F.	5-15
A1A3R239		RESISTOR: MIL type RN60C1822F.	5-15
A1A3R240 to A1A3R243		Not Used.	
A1A3R244		RESISTOR: Same as A1A1R139.	5-15
A1A3R245		RESISTOR: MIL type RN60C30R1F.	5-15
A1A3R246		RESISTOR, VARIABLE, WIRE WOUND: 100 ohms ±5% 1w; mfr 28480, P/N 2100-1770.	5-15
A1A3R247		RESISTOR: MIL type RN60C1500F.	5-15
A1A3R248		RESISTOR, VARIABLE, WIRE WOUND: 200 ohms ±5%, 1w; mfr 28480, P/N 2100-1771.	5-15
A1A3R249		RESISTOR: MIL type RN60C3320F.	5-15
A1A3R250		RESISTOR, VARIABLE, WIRE WOUND: 1k ohms ±10%, 1/2w; mfr 28480, P/N 2100-1773.	5-15
A1A3R251		RESISTOR: MIL type RN60C1621F.	5-15
A1A3R252		RESISTOR, FIXED, METAL FILM: 21.5k ohms ±1%, 1/2w; mfr 19701, P/N MF7C-D2152F.	5-15
A1A3R253		RESISTOR, VARIABLE, WIRE WOUND: 5k ohms ±5%, 1w; mfr 28480, P/N 2100-0741.	5-15
A1A3R254		RESISTOR: Same as A1A3R252.	
A1A3R255		Not Used.	
A1A3R256		Not Used.	
A1A3R257		RESISTOR: Same as A1A1R137.	5-15
A1A3R258		RESISTOR: Same as A1A3R208.	5-15
A1A3R259		RESISTOR: MIL type RN60C1501F.	5-15
A1A3R260		Not Used.	
A1A3R261		RESISTOR: Same as A1A3R225.	5-15
A1A3R262		RESISTOR: Same as A1A1R107.	5-15
A1A3R263		RESISTOR: MIL type RN60C5621F.	5-15
A1A3R264		RESISTOR: Same as A1A3R230.	5-15
A1A3R265 to A1A3R267		Not Used.	
A1A3R268		RESISTOR: Same as A1A1R130.	5-15
A1A3R269		RESISTOR: Same as A1A3R232.	5-15
A1A3R270		RESISTOR: Same as A1A3R235.	5-15
A1A3R271		RESISTOR: Same as A1A3R234.	5-15
A1A3R272		Not Used.	
A1A3R273		RESISTOR: Same as A1A1R102.	5-15
A1A3R274		Not Used.	
A1A3R275		RESISTOR: Same as A1A3R238.	5-15

TABLE 6-1. (Continued)

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG. NO.
A1A3R300 to A1A3R334		Not Used.	
A1A3R335		RESISTOR: Same as A1A1R125.	5-15
A1A3R336		RESISTOR, VARIABLE, METAL FILM: 20k ohms ±30%; mfr 73138, P/N 62P-R20K.	5-15
A1A3R337		RESISTOR: Same as A1A1R125.	5-15
A1A3S200		Not Used.	
A1A3S201		Not Used.	
A1A3S202		SWITCH, SLIDE: SPDT; mfr 79727, P/N 6938.	5-15
A1A4		CIRCUIT BOARD, HIGH VOLTAGE OSCILLATOR: Printed circuit board w/all components assembled for operation; mfr 28480, P/N 00180-66515.	5-16 5-16
A1A4C300 to A1A4C306		Not Used.	
A1A4C307		CAPACITOR: MIL type CS13BF476K.	5-16
A1C4C308		CAPACITOR, FIXED, MYLAR: 0.22 uf ±10%, 200 vdc; mfr 56289, P/N 192P22492-PTS.	5-16
A1A4CR300		Not Used.	
A1A4CR301		DIODE, SILICON: Mfr 04713, P/N SR1358-6.	5-16
A1A4L300		Not Used.	
A1A4L301		INDUCTOR, FIXED: 22 uh; mfr 95265, P/N QB22-1.	5-16
A1A5		CIRCUIT BOARD, HIGH VOLTAGE RECTIFIER: Printed circuit board w/all components assembled for operation; mfr 28480, P/N 00180-66509.	5-17
A1A5C300 to A1A5C308		Not Used.	
A1A5C309		CAPACITOR: Same as A1A1C310	5-17
A1A5C310 to A1A5C314		Not Used.	
A1A5C315		CAPACITOR: Same as A1A1C311	5-17
A1A5CR300		Not Used.	
A1A5CR301		Not Used.	
A1A5CR302		DIODE, SILICON: Mfr 28480, P/N 1901-0341.	5-17
A1A5CR303 to A1A5CR306		Not Used.	
A1A5CR307		DIODE: Same as A1A5CR302.	
A1A5R300 to A1A5R324		Not Used.	
A1A5R325		RESISTOR: MIL type RC07GF2235J.	5-17
A1A5R326		RESISTOR, VARIABLE, COMPOSITION: 1 megohm ±20%, linear, 1/5w; mfr 28480, P/N 2100-1618.	5-17
A1A5R327		RESISTOR, FIXED, DEPOSITED CARBON: 29 megohms ±10%, 1w; mfr 28480, P/N 0836-0003.	5-17
A1A5T300		Not Used.	

TABLE 6-1. (Continued)

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG. NO.
A1A5T301		TRANSFORMER, HIGH VOLTAGE: Mfr 28480, P/N 00180-60801.	5-17
A1A6		CIRCUIT BOARD, LOW VOLTAGE RECTIFIER: Printed circuit board w/all components assembled for operation; mfr 28480, P/N 00180-66514.	5-18 5-18
A1A6C400		Not Used.	
A1A6C401		CAPACITOR, FIXED, ELECTROLYTIC: 100 uf, 20 vdcw; mfr 56289, P/N 500D107G020DD4.	5-18
A1A6CR400		Not Used.	
A1A6CR401		DIODE: Same as A1A4CR301.	5-18
A1A6CR402		DIODE: Same as A1A4CR301.	5-18
A1A6CR403		DIODE: Same as A1A4CR301.	5-18
A1A6CR404		DIODE: Same as A1A4CR301.	5-18
A1A6CR405 to A1A6CR407		Not Used.	
A1A6CR408		DIODE, SILICON: Mfr 28480, P/N 1901-0028.	5-18
A1A6CR409		DIODE: Same as A1A6CR408.	5-18
A1A6CR410		DIODE: Same as A1A6CR408.	5-18
A1A6CR411		DIODE: Same as A1A6CR408	5-18
A1A6CR412		Not Used.	
A1A6CR413		DIODE: Same as A1A4CR301.	5-18
A1A6CR414		DIODE: Same as A1A4CR301.	5-18
A1A6CR415		DIODE: Same as A1A4CR301.	5-18
A1A6CR416		DIODE: Same as A1A4CR301.	5-18
A1A6CR417 to A1A6CR420		Not Used.	
A1A6CR421		DIODE: Same as A1A4CR301.	5-18
A1A6CR422		DIODE: Same as A1A4CR301.	5-18
A1A6CR423		DIODE: Same as A1A4CR301.	5-18
A1A6CR424		DIODE: Same as A1A4CR301.	5-18
A1A6CR425		Not Used.	
A1A6CR426		DIODE: Same as A1A6CR408.	5-18
A1A6CR427		DIODE: Same as A1A6CR408.	5-18
A1A6CR428		DIODE: Same as A1A6CR408.	5-18
A1A6CR429		DIODE: Same as A1A6CR408.	5-18
A1A6R400		Not Used.	
A1A6R401		Not Used.	
A1A6R402		RESISTOR, FIXED, WIRE WOUND: 10 ohms ±5%, 2w; mfr 75042, P/N BWH 10.	5-18
A1A6R403		RESISTOR: Same as A1A1R318.	5-18
A1A6R404 to A1A6R438		Not Used.	
A1A6R439		RESISTOR: Same as A1A6R402.	5-18
A1A6R440		RESISTOR: Same as A1A1R318.	5-18
A1A7		CIRCUIT BOARD, LOW VOLTAGE POWER SUPPLY: Printed circuit board w/all components assembled for operation; mfr 28480, P/N 00180-66513.	5-19 5-19
A1A7C400 to A1A7C405		Not Used.	

TABLE 6-1. (Continued)

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG. NO.
A1A7C406		CAPACITOR, FIXED, MYLAR: 0.1 uf ±10%, 200 vdcw; mfr 56289, P/N 192P10492-PTS.	5-19
A1A7C407		CAPACITOR: MIL type CSK13BGF475KM.	5-19
A1A7C408		CAPACITOR, FIXED, ELECTROLYTIC: 18 uf, 150 vdcw; mfr 56289, P/N 600D186F150DG4.	5-19
A1A7C409 to A1A7C412		Not Used.	
A1A7C413		CAPACITOR: Same as A1A7C406.	5-19
A1A7C414		CAPACITOR: Same as A1A4C307.	5-19
A1A7C415 to A1A7C418		Not Used.	
A1A7C419		CAPACITOR: Same as A1A7C406.	5-19
A1A7C420		CAPACITOR: Same as A1A4C307.	5-19
A1A7C421 to A1A7C424		Not Used.	
A1A7C425		CAPACITOR: Same as A1A7C406.	5-19
A1A7C426		CAPACITOR: Same as A1A7C407.	5-19
A1A7C427		CAPACITOR: Same as A1A7C408	5-19
A1A7CR400 to A1A7CR404		Not Used.	
A1A7CR405		DIODE: Same as A1A1CR102	5-19
A1A7CR406		DIODE: Same as A1A1CR102.	5-19
A1A7CR407		DIODE: Same as A1A1CR102.	5-19
A1A7CR408 to A1A7CR411		Not Used.	
A1A7CR412		DIODE, SILICON: Mfr 04713, P/N SR 1358-8.	5-19
A1A7CR413 to A1A7CR416		Not Used.	
A1A7CR417		DIODE: Same as A1A1CR102.	5-19
A1A7CR418		Not Used.	
A1A7CR419		DIODE: Same as A1A1CR102.	5-19
A1A7CR420		DIODE: Same as A1A1CR102.	5-19
A1A7CR421 to A1A7CR424		Not Used.	
A1A7CR425		DIODE: Same as A1A1CR102.	5-19
A1A7CR426 to A1A7CR429		Not Used.	
A1A7CR430		DIODE: Same as A1A7CR412.	5-19
A1A7CR431		Not Used.	
A1A7CR432		DIODE: Same as A1A1CR102.	5-19
A1A7CR433		DIODE: Same as A1A1CR102.	5-19
A1A7CR434		DIODE: Same as A1A1CR102.	5-19
A1A7Q400		Not Used.	
A1A7Q401		Not Used.	
A1A7Q402		TRANSISTOR, SILICON, NPN: Mfr 04713, P/N SM8158.	5-19
A1A7Q403		TRANSISTOR, SILICON, NPN: Mfr 04713, P/N MPS3417.	5-19
A1A7Q404		TRANSISTOR: Same as A1A1Q302.	5-19
A1A7Q405		TRANSISTOR: Same as A1A1Q303.	5-19
A1A7Q406		Not Used.	
A1A7Q407		TRANSISTOR: Same as A1A1Q302.	5-19
A1A7Q408		TRANSISTOR: Same as A1A1Q302.	5-19
A1A7Q409		TRANSISTOR: Same as A1A1Q303.	5-19
A1A7Q410		Not Used.	

TABLE 6-1. (Continued)

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG. NO.
A1A7Q411		TRANSISTOR: Same as A1A1Q302.	5-19
A1A7Q412		TRANSISTOR: Same as A1A1Q302.	5-19
A1A7Q413		TRANSISTOR: Same as A1A7Q402.	5-19
A1A7Q414		Not Used.	
A1A7Q415		TRANSISTOR: Same as A1A7Q403.	5-19
A1A7Q416		TRANSISTOR: Same as A1A1Q302.	5-19
A1A7R400		Not Used.	
A1A7R401		RESISTOR: Same as A1A1R125.	5-19
A1A7R402 to A1A7R403		Not Used.	
A1A7R404		RESISTOR: Same as A1A1R125.	5-19
A1A7R405		RESISTOR: MIL type RN60C82R5F.	5-19
A1A7R406		RESISTOR: MIL type $N70C3012F.	5-19
A1A7R407		RESISTOR: Same as ApA3R263.	5-19
A1A7R408		RESISTOR: Same as A1A1R129.	5-19
A1A7R409		RESISTOR: Same as A1A3R223.	5-19
A1A7R410		RESISTOR: Same as A1A3R245.	5-19
A1A7R411		RESISTOR: Same as A1A3R263.	5-19
A1A7R412		RESISTOR, VARIABLE, WIRE WOUND: 2k ohms ±10%, 1/2w; mfr 28480, P/N 2100-1774.	5-19
A1A7R413		RESISTOR: MIL type RN70C6812F.	5-19
A1A7R414 to A1A7R416		Not Used.	
A1A7R417		RESISTOR: MIL type RN60C30R1F.	5-19
A1A7R418		RESISTOR: MIL type RN70C3322F.	5-19
A1A7R419		RESISTOR, FIXED, WIRE WOUND: 0.36 ohms ±5%, 2w; mfr 28480, P/N 0811-1746.	5-19
A1A7R420		RESISTOR: Same as A1A3R210.	5-19
A1A7R421		RESISTOR: MIL type RN60C4323F.	5-19
A1A7R422		RESISTOR: Same as A1A1R130.	5-19
A1A7R423		RESISTOR, VARIABLE, WIRE WOUND: 500 ohms ±10%, 1/2w; mfr 28480, P/N 2100-1772.	5-19
A1A7R424		RESISTOR: MIL type RN70C2432F.	5-19
A1A7R425 to A1A7R427		Not Used.	
A1A7R428		RESISTOR: Same as A1A3R245.	5-19
A1A7R429		RESISTOR: Same as A1A7R406.	5-19
A1A7R430		RESISTOR: Same as A1A7R419.	5-19
A1A7R431		RESISTOR: Same as A1A1R318.	5-19
A1A7R432		RESISTOR: MIL type RN60C3323F.	5-19
A1A7R433		RESISTOR: Same as A1A1R130.	5-19
A1A7R434		RESISTOR: Same as A1A7R423.	5-19
A1A7R435		RESISTOR: Same as A1A7R424.	5-19
A1A7R436 to A1A7R440		Not Used.	
A1A7R441		RESISTOR: Same as A1A1R125.	5-19
A1A7R442		RESISTOR: Same as A1A7R405.	5-19
A1A7R443		RESISTOR: Same as ApA7R406.	5-19
A1A7R444		RESISTOR: Same as A1A3R263.	5-19
A1A7R445		RESISTOR: Same as A1A1R318.	5-19
A1A7R446		RESISTOR: Same as A1A3R223.	5-19
A1A7R447		RESISTOR: Same as A1A3R245.	5-19
A1A7R448		RESISTOR: Same as ApA2R151.	5-19
A1A7R449		RESISTOR: Same as A1A3R250.	5-19
A1A7R450		RESISTOR: Same as A1A3R252.	5-19
A1A7TP400		Not Used.	

TABLE 6-1. (Continued)

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG. NO.
A1A7TP401		JACK, TEST: Same as A1A1TP301.	5-19
A1A7TP402		JACK, TEST: Same as A1A1TP301.	5-19
A1A7TP403		JACK, TEST: Same as A1A1TP301.	5-19
A1A7TP404		JACK, TEST: Same as A1A1TP301.	5-19
A1A7V400		Not Used.	
A1A7V401		TUBE, VOLTAGE REFERENCE: 82 volts; mfr 74276, P/N Z82R7.	5-19
A1A7V402		TUBE: Same as A1A7V401.	5-19
A1A7VR400		Not Used.	
A1A7VR401		DIODE; ZENER: 5.23 V, 400 mw; mfr 01281, P/N PS18233A.	5-19
A1A7VR402		DIODE, ZENER: 54.6 v, 400 mw; mfr 04713 P/N SZ10939-395.	5-19
A1A7VR403		DIODE: Same as A1A7VR402.	5-19
A1A8		TRIPLER ASSEMBLY, HIGH VOLTAGE: Box w/all components assembled for operation; mfr 28480, P/N 00180-61101.	5-10
A1C100		Not Used.	
A1C101		CAPACITOR: Same as A1A7C406.	5-10
A1C200		Not Used.	
A1C201		CAPACITOR, FIXED, MYLAR: 0.1 uf ±20%, 600 vdcw; mfr 56289, P/N 148P175A.	5-10
A1C400 to A1C404		Not Used.	
A1C405		CAPACITOR, FIXED, ELECTROLYTIC: 430 uf, 200 vdcw; mfr 56289, P/N 32D431F200AB2A.	5-10
A1C406 to A1C411		Not Used.	
A1C412		CAPACITOR, FIXED, ELECTROLYTIC: 2100 uf, 40 vdcw; mfr 56289, P/N 32D212GO40AB6A.	5-10
A1C413 to A1C417		Not Used.	
A1C418		CAPACITOR, FIXED, ELECTROLYTIC: 3400 uf, 25 vdcw; mfr 56289, P/N 32D342G025AB2A.	5-10
A1C419 to A1C423		Not Used.	
A1C424		CAPACITOR, FIXED, ELECTROLYTIC: 290 uf, 200 vdcw; mfr 56289, P/N 32D291F200AB2A.	5-10
A1DS400		Not Used.	
A1DS401		LIGHT, INDICATOR: Mfr 08717, P/N 102SR-G-FB13.	5-10
A1F300		Not Used.	
A1F301		FUSE: MIL type MS90078-7.	5-10
A1F400		Not Used.	
A1F401		FUSE, SLOW BLOW: 3AG, 125v, 1-1/4 amp; mfr 71400, P/N MDL1-1/4.	5-10
A1F402		FUSE: Same as A1F401.	5-10
A1F403		FUSE: 3AG, 250 v, 3/10 amp; mfr 71400, P/N AGC3/10.	5-10
A1F404		FUSE: MIL type MS90078-9.	5-10
A1F405		FUSE: Same as A1F404.	5-10
A1F406		FUSE: Same as A1F403.	5-10

TABLE 6-1. (Continued)

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG. NO.
A1FL400		Not Used.	
A1FL401		FILTER, LINE: Mfr 28480, P/N 9110-2483.	5-10
A1J1		CONNECTOR, RECEPTACLE: 32-contact, female; mfr 02660, P/N 264200-32S.	5-10
A1J2		CONNECTOR, CONTACT: 2 pin; mfr 28480, P/N 0363-0006.	5-10
A1J100		Not Used.	
A1J101		CONNECTOR, BNC, FEMALE: Mfr 95712, P/N 30624-1.	5-10
A1J102		JACK, BANANA: Mfr 83330, P/N 219-2.	5-10
A1J103		JACK: Same as A1J102.	5-10
A1J104		Not Used.	
A1J105		CONNECTOR: Same as A1J101.	5-10
A1J106		CONNECTOR: Same as A1J101.	5-10
A1J107		CONNECTOR: Same as A1J101.	5-10
A1J108		CONNECTOR: Same as A1J101.	5-10
A1J200		Not Used.	
A1J201		CONNECTOR: Same as A1J101.	5-10
A1J400		Not Used.	
A1J401		Not Used.	
A1J402		POST BINDING: Mfr 28480, P/N 1510-0038.	5-10
A1L100		Not Used.	
A1L101		INDUCTOR: Same as A1A1L102.	5-10
A1L300		Not Used.	
Q1L301		Not Used.	
A1L302		COIL, ALIGNMENT: Trace align; mfr 28480, P/N 5060-0435.	5-10
A1L303		COIL, ALIGNMENT: Y align; mfr 28480, P/N 00180-65601.	5-10
A1MP100		KNOB ASSEMBLY: Horizontal magnifier; mfr 28480, P/N 00180-67404.	5-10
A1MP101		KNOB ASSEMBLY: Horizontal position, coarse; mfr 28480, P/N 00180-67402.	5-10
A1MP102		KNOB ASSEMBLY: Horizontal display; Same as A1MP2.	5-10
A1MP103		LEVER: Horizontal position, Fine; mfr 28480, P/N 00180-05002.	5-10
A1MP104		KNOB, LEVER: Mfr 28480, P/N 0370-0432.	5-10
A1MP105		PUSH-BUTTON: Find beam; mfr 28480, P/N 0370-0350.	5-10
A1MP106		KNOB ASSEMBLY: Intensity; mfr 28480, P/N 0370-0348.	5-10
A1MP107		KNOB ASSEMBLY: Focus; mfr 28480, P/N 00180-67401.	5-10
A1MP108		KNOB ASSEMBLY: Scale; mfr 28480, P/N 00180-67403.	5-10
A1MP109		FOOT, REAR, LONG: Mfr 28480, P/N 5040-0447.	5-10
A1MP110		FOOT, REAR, SHORT: Mfr 28480, P/N 5040-0446.	5-10
A1MP111		SHIELD, LIGHT: Mfr 28480, P/N 5040-0444.	5-10
A1MP112		GASKET, SHOCK MOUNTING: Mfr 28480, P/N 0905-0331.	5-10
A1MP113		FOOT, BOTTOM: 2 required; mfr 28480, P/N 5040-0445.	5-10
A1MP114		STAND, TILT: Mfr 28480, P/N 1490-0710.	5-10
A1MP115		HANDLE: Mfr 28480, P/N 5040-0459.	5-10
A1MP116		COVER, FUSE: Mfr 28480, P/N 00180-44103.	5-10
A1MP117		COUPLER, SHORT: 2 required; mfr 28480, P/N 00180-23203.	5-10
A1MP118		COUPLER, FOCUS: Mfr 28480, P/N 00180-23201.	5-10
A1MP119		FILTER, MESH CONTRAST: Mfr 28480, P/N 10178-60501.	5-10
A1Q300 to A1Q303		Not Used.	
A1Q304		TRANSISTOR, SILICON, NPN: Mfr 04713, P/N SJ1266.	5-10
A1Q400		Not Used.	
A1Q401		TRANSISTOR, SILICON, NPN: MIL type 2N3055.	5-10

TABLE 6-1. (Continued)

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG. NO.
A1Q402 to A1Q405		Not Used.	
A1Q406		TRANSISTOR: Same as A1Q401.	5-10
A1Q407 to A1Q409		Not Used.	
A1Q410		TRANSISTOR: Same as A1Q401.	5-10
A1Q411 to A1Q413		Not Used.	
A1Q414		TRANSISTOR: Same as A1Q401.	5-10
A1R100		Not Used.	
A1R101		RESISTOR: Same as A1A1R129.	5-10
A1R102 to A1R105		Not Used.	
A1R106		RESISTOR, VARIABLE, COMPOSITION: 10k ohms ±20%, 1/4w; mfr 28480, 2100-1904.	5-10
A1R200 to A1R210		Not Used.	
A1R211		RESISTOR, VARIABLE, COMPOSITION: 50k ohms ±3%, 1/2w; part of A1S101.	5-10
A1R212 to A1R217		Not Used.	
A1R218		RESISTOR, VARIABLE, COMPOSITION: 100k ohms ±20%, (includes A1R221); mfr 28480, P/N 2100-2076.	5-10
A1R219		Not Used.	
A1R220		Not Used.	
A1R221		NOT SEPARATELY REPLACEABLE - Part of A1R218.	5-10
A1R331		Not Used.	
A1R333		Not Used.	
A1R334		RESISTOR, VARIABLE, WIRE WOUND: 5k ohms ±10%, 2w; mfr 28480, P/N 2100-1903.	5-10
A1R335 to A1R343		Not Used.	
A1R344		RESISTOR, VARIABLE, COMPOSITION: 5 megohms ±10%, 1/2w; mfr 28480, P/N 2100-1906.	5-10
A1R345		Not Used.	
A1R346		RESISTOR, FIXED, COMPOSITION: 100k ohms ±5%, 1/4w; mfr 01121, P/N CB1045.	5-10
A1R347		RESISTOR, VARIABLE, COMPOSITION: 50k ohms ±20%, 1/2w; mfr 28480, P/N 2100-1905.	5-10
A1R348		Not Used.	
A1R349		Not Used.	
A1R350		RESISTOR, VARIABLE, WIRE WOUND: 100 ohms ±10%, 2w; mfr 28480, P/N 2100-1901.	5-10
A1S100		Not Used.	
A1S101		SWITCH, ROTARY: Includes R211; mfr 28480, P/N 3100-1344.	5-10
A1S102		SWITCH, PUSHBUTTON: DPDT; mfr 82389, P/N 12S1-032.	5-10
A1S200		Not Used.	
A1S201		SWITCH, SLIDE: DPDT, 1/2 amp, 12 vac; mfr 79727, P/N G126.	5-10
A1S202		Not Used.	
A1S203		SWITCH, ROTARY: 3-position; mfr 28480, P/N 3100-1345.	5-10
A1S400		Not Used.	

TABLE 6-1. (Continued)

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG. NO.
A1S401		SWITCH, TOGGLE: DPDT, 5 amp 115 vac; mfr 09353, P/N 7201-WHT-GW.	5-10
A1S402		SWITCH, SLIDE: DPDT, VOLTS AC, mfr 82389, P/N 11A-1037.	5-10
A1T400		Not Used.	
A1T401		TRANSFORMER, POWER: 50/1000 cps at 115/230 vac input, 4.9/6.9/9.4/16.4/21.3/106 vac output, solder type terminals; mfr 28480, P/N 9100-1109.	5-10
A1V300 to A1V302		Not Used.	
A1V303		TUBE, CATHODE RAY: Mfr 28480, P/N 5083-9023.	5-10
A1XF400		Not Used.	
A1XF401		POST, FUSE: Mfr 75915, P/N 342014.	5-10
A1XF402		POST, FUSE: Same as A1XF401.	5-10
A1XV300 to A1XV302		Not Used.	
A1XV303		SOCKET, CRT: Mfr 72825, P/N 9709-4.	5-10
A2		DUAL TRACE OSCILLOSCOPE PLUG-IN UNIT: MIL type PL-1186/USM-281.	5-11
A2A1		ATTENUATOR ASSEMBLY, "A" CHANNEL: Switch w/all components assembled for operation; mfr 28480, P/N 01801-63401.	5-20
A2A1C100		Not Used.	
A2A1C101		CAPACITOR, FIXED, MYLAR: 0.1 uf ±20%, 600 vdcw; mfr 01281, P/N HEW9810406W.	5-20
A2A1C102		Not Used.	
A2A1C103		CAPACITOR, VARIABLE, POLYSTYRENE: 0.7 to 3.0 pf, 350 vdcw; mfr 72982, P/N 535-031-4R.	5-20
A2A1C104		CAPACITOR, FIXED, CERAMIC: 12 pf ±5%, 500 vdcw; mfr 72982, P/N 301-000-C0G0-120J.	5-20
A2A1C105		CAPACITOR: Same as A1A1C113.	5-20
A2A1C106		Not Used.	
A2A1C107		CAPACITOR: Same as A2A1C103.	5-20
A2A1C108		CAPACITOR: Same as A2A1C104.	5-20
A2A1C109		CAPACITOR: Same as A1A1C113.	5-20
A2A1C110		CAPACITOR, FIXED, MICA: 100 pf ±10%, 500 vdcw; mfr 72982, P/N 652-020-101K.	5-20
A2A1C111		Not Used.	
A2A1C112		CAPACITOR, VARIABLE, POLYSTYRENE: 0.7 to 3.0 pf, 350 vdcw; mfr 72982, P/N 535-015-4R.	5-20
A2A1C113		CAPACITOR: Same as A2A1C104.	5-20
A2A1C114		CAPACITOR: Same as A1A1C113.	5-20
A2A1C115		CAPACITOR, FIXED, MICA: 1000 pf ±10%, 500 vdcw; mfr 72982, P/N 666-003-102K.	5-20
A2A1C116		Not Used.	
A2A1C117		Not Used.	
A2A1C118		CAPACITOR: Same as A2A1C112.	5-20
A2A1C119		CAPACITOR: MIL type CC20CK2R2C.	5-20
A2A1C120		CAPACITOR: Same as A1A1C110.	5-20
A2A1C121		CAPACITOR, FIXED, CERAMIC: 10 pf ±5%, 500 vdcw; mfr 72982, P/N 301-000-C0H0-10CJ.	5-20
A2A1C122		Not Used.	
A2A1C123		CAPACITOR: Same as A2A1C103.	5-20
A2A1C124		CAPACITOR, FIXED, CERAMIC: 5.1 pf ±0.25 pf, 500 vdcw; mfr 72982, P/N 301-000-C0H0-519C.	5-20
A2A1C125		CAPACITOR: Same as A1A1C110.	5-20

TABLE 6-1. (Continued)

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG. NO.
A2A1C126		CAPACITOR: Same as A2A1C119.	5-20
A2A1R100		RESISTOR: MIL type RN60C75R0F.	5-20
A2A1R101		RESISTOR, FIXED, METAL FILM: 900k ohms ±1/2%, 1/4w; mfr 19701, P/N MF6C-D9003D.	5-20
A2A1R102		RESISTOR, FIXED, METAL FILM: 111k ohms ±1%, 1/8w; mfr 19701, P/N MF5C-D1113F.	5-20
A2A1R103		Not Used.	
A2A1R104		RESISTOR, FIXED, METAL FILM: 990k ohms ±1/2%, 1/4w; mfr 19701, P/N MF6C-D9903D.	5-20
A2A1R105		RESISTOR, FIXED, METAL FILM: 10.1k ohms ±1%, 1/8w; mfr 19701, P/N MF5C-D1012F.	5-20
A2A1R106		Not Used.	
A2A1R107		RESISTOR, FIXED, METAL FILM: 999k ohms ±1/4%, 1/4w; mfr 19701, P/N MF6C-D9993C.	5-20
A2A1R108		RESISTOR: Same as A1A1R125.	5-20
A2A1R109		Not Used.	
A2A1R110		Not Used.	
A2A1R111		RESISTOR: Same as A1A3R245.	5-20
A2A1R112		RESISTOR, FIXED, METAL FILM: 500k ohms ±1%, 1/8w; mfr 19701, P/N MF5C-D5003F.	5-20
A2A1R113		RESISTOR: Same as A1A3R202.	5-20
A2A1R114		Not Used.	
A2A1R115		RESISTOR, FIXED, METAL FILM: 750k ohms ±1%, 1/8w; mfr 28480, P/N 0757-0486.	5-20
A2A1R116		RESISTOR, FIXED, METAL FILM: 333k ohms ±1%, 1/8w; mfr 19701, P/N MF5C-D3333F.	5-20
A2A1R117		Not Used.	
A2A1R118		RESISTOR: Same as A1A3R202.	
A2A1R300 to A2A1R308		Not Used.	
A2A1R309		RESISTOR, VARIABLE, COMPOSITION: 10k ohms ±10%, 1/4w; mfr 28480, P/N 2100-2008.	5-20
A2A1S100		Not Used.	
A2A1S101		Not Used.	
A2A1S102		SWITCH, ROTARY: 4-section, 12-position; mfr 28480, P/N 3100-1340.	5-20
A2A2		ATTENUATOR ASSEMBLY, "B" CHANNEL: Switch w/all components assembled for operation; mfr 28480, P/N 01801-63402.	5-21
A2A2C200		Not Used.	
A2A2C201		CAPACITOR: Same as A2A1C101.	5-21
A2A2C202		Not Used.	
A2A2C203		CAPACITOR: Same as A2A1C103.	5-21
A2A2C204		CAPACITOR: Same as A2A1C104.	5-21
A2A2C205		CAPACITOR: Same as A2A1C113.	5-21
A2A2C206		Not Used.	
A2A2C207		CAPACITOR: Same as A2A1C103.	5-21
A2A2C208		CAPACITOR: Same as A2A1C104.	5-21
A2A2C209		CAPACITOR: Same as A1A1C113.	5-21
A2A2C210		CAPACITOR: Same as A2A1C110.	5-21
A2A2C211		Not Used.	
A2A2C212		CAPACITOR: Same as A2A1C112.	5-21
A2A2C213		CAPACITOR: Same as A2A1C104.	5-21
A2A2C214		CAPACITOR: Same as A1A1C113.	5-21
A2A2C215		CAPACITOR: Same as A2A1C115.	5-21

TABLE 6-1. (Continued)

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG. NO.
A2A2C216		Not Used.	
A2A2C217		Not Used.	
A2A2C218		CAPACITOR: Same as A2A1C112.	5-21
A2A2C219		CAPACITOR: Same as A2A1C119.	5-21
A2A2C220		CAPACITOR: Same as A1A1C110.	5-21
A2A2C221		CAPACITOR: Same as A2A1C121.	5-21
A2A2C222		Not Used.	
A2A2C223		CAPACITOR: Same as A2A1C103.	5-21
A2A2C224		CAPACITOR: Same as A2A1C124.	5-21
A2A2C225		CAPACITOR: Same as A1A1C110.	5-21
A2A2C226		CAPACITOR: Same as A2A1C119.	5-21
A2A2R200		RESISTOR: Same as A2A1R100.	5-21
A2A2R201		RESISTOR: Same as A2A1R101.	5-21
A2A2R202		RESISTOR: Same as A2A1R102.	5-21
A2A2R203		Not Used.	
A2A2R204		RESISTOR: Same as A2A1R104.	5-21
A2A2R205		RESISTOR: Same as A2A1R105.	5-21
A2A2R206		Not Used.	
A2A2R207		RESISTOR: Same as A2A1R107.	5-21
A2A2R208		RESISTOR: Same as A1A1R125.	5-21
A2A2R209		Not Used.	
A2A2R210		Not Used.	
A2A2R211		RESISTOR: Same as A1A3R245.	5-21
A2A2R212		RESISTOR: Same as A2A1R112.	5-21
A2A2R213		RESISTOR: Same as A1A3R202.	5-21
A2A2R214		Not Used.	
A2A2R215		RESISTOR: Same as A2A1R115.	5-21
A2A2R216		RESISTOR: Same as A2A1R116.	5-21
A2A2R218		RESISTOR: Same as A1A3R202.	5-21
A2A2R400 to A2A2R408		Not Used.	
A2A2R409		RESISTOR: Same as A2A1R309.	5-21
A2A2S200		Not Used.	
A2A2S201		Not Used.	
A2A2S202		SWITCH: Same as A2A1S102.	5-21
A2A3		CIRCUIT BOARD, AMPLIFIER, MAIN: Printed circuit board w/all components assembled for operation; mfr 28480, P/N 01801-66511.	5-22
A2A3C100 to A2A3C128		Not Used.	
A2A3C129		CAPACITOR, FIXED, CERAMIC: 0.02 uf +80% -20%, 600 vdcw; mfr 72982, P/N 841000Z5U203Z.	5-22
A2A3C200 to A2A3C228		Not Used.	
A2A3C229		CAPACITOR: Same as A2A3C129.	5-22
A2A3C300		Not Used.	
A2A3C301		CAPACITOR, VARIABLE, CERAMIC: 9 to 35 pf, 500 vdcw; mfr 72982, P/N 538-011E2P094R.	5-22
A2A3C302 to A2A3C304		Not Used.	

TABLE 6-1. (Continued)

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG. NO.
A2A3C305		CAPACITOR: Same as A1A1C110.	5-22
A2A3C306		CAPACITOR: Same as A1A1C110.	5-22
A2A3C307		CAPACITOR: MIL type CS13BG105M.	5-22
A2A3C308		CAPACITOR, FIXED, CERAMIC: 1000 pf, 600 vdcw; mfr 28480, P/N 0150-0050.	5-22
A2A3C309		CAPACITOR: Same as A2A3C308.	5-22
A2A3C310		Not Used.	
A2A3C311		CAPACITOR: MIL type CM05FC101G03.	5-22
A2A3C312		CAPACITOR: Same as A2A3C311.	5-22
A2A3C313		CAPACITOR, FIXED, MYLAR: 1000 pf ±10%, 20 vdcw; mfr 56289, P/N 192P10292-PTS.	5-22
A2A3C314		CAPACITOR: Same as A2A3C313.	5-22
A2A3C315		CAPACITOR: MIL type CM05FC201F03.	5-22
A2A3C316		CAPACITOR: Same as A2A3C301.	5-22
A2A3C317		CAPACITOR: MIL type CM05FC330J03.	5-22
A2A3C400		Not Used.	
A2A3C401		CAPACITOR: Same as A2A3C301.	5-22
A2A3C402 to A2A3C404		Not Used.	
A2A3C405		CAPACITOR: Same as A1A1C110.	5-22
A2A3C406		CAPACITOR: Same as A1A1C110.	5-22
A2A3C407		CAPACITOR: Same as A2A3C307.	5-22
A2A3C408		CAPACITOR: Same as A2A3C308.	5-22
A2A3C409		CAPACITOR: Same as A2A3C308.	5-22
A2A3C410		Not Used.	
A2A3C411		CAPACITOR: Same as A2A3C311.	5-22
A2A3C412		CAPACITOR: Same as A2A3C311.	5-22
A2A3C413		CAPACITOR: Same as A2A3C313.	5-22
A2A3C414		CAPACITOR: Same as A2A3C313.	
A2A3C415		CAPACITOR: Same as A2A3C315.	5-22
A2A3C416		CAPACITOR: Same as A2A3C301.	5-22
A2A3C417		CAPACITOR: MIL type CM05FD470J03.	5-22
A2A3C500		Not Used.	
A2A3C501		CAPACITOR, VARIABLE, CERAMIC: 2 to 8 pf, 300 vdcw; mfr 72982, P/N 538-011-C0P0-89R.	5-22
A2A3C502		CAPACITOR, FIXED, CERAMIC: 12 pf ±5%, 500 vdcw; mfr 72982, P/N 301-000-C0G0-120J.	5-22
A2A3C503		CAPACITOR: Same as A2A3C502.	5-22
A2A3C504		Not Used.	
A2A3C505		CAPACITOR: Same as A2A3C307.	5-22
A2A3C506		CAPACITOR: Same as A2A3C311.	5-22
A2A3C507		CAPACITOR, VARIABLE, CERAMIC: 5.5 to 18 pf, 300 vdcw; mfr 72982, P/N 538-011-C0P0-92R.	5-22
A2A3C508		CAPACITOR: MIL type CM05FC560J03.	5-22
A2A3C509		CAPACITOR: MIL type CM05CD120J03.	5-22
A2A3C510		CAPACITOR: Same as A2A3C507.	5-22
A2A3C511		Not Used.	
A2A3C512		CAPACITOR: Same as A2A3C307.	5-22
A2A3C513 to A2A3C515		Not Used.	
A2A3C516		CAPACITOR: Same as A2A3C307.	5-22
A2A3C517		CAPACITOR: MIL type CS13BF685K.	5-22

TABLE 6-1. (Continued)

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG. NO.
A2A3C518		CAPACITOR: Same as A2A3C307.	5-22
A2A3C519		CAPACITOR: Same as A2A3C307.	5-22
A2A3C520		CAPACITOR: Same as A2A3C307.	5-22
A2A3C521		CAPACITOR: Same as A2A3C307.	5-22
A2A3C522		Not Used.	5-22
A2A3C523		CAPACITOR: Same as A2A3C307.	5-22
A2A3C524		CAPACITOR: Same as A2A3C307.	5-22
A2A3C525 to A2A3C527		Not Used.	
A2A3C528		CAPACITOR: Same as A2A3C517.	5-22
A2A3C529		CAPACITOR: Same as A2A3C307.	5-22
A2A3C530 to A2A3C532		Not Used.	
A2A3C533		CAPACITOR: Same as A2A3C307.	5-22
A2A3C534		CAPACITOR: MIL type CSR13D226KM.	5-22
A2A3C535		CAPACITOR: Same as A2A3C307.	5-22
A2A3C536		CAPACITOR: Same as A2A3C534.	5-22
A2A3C1100		Not Used.	
A2A3C1101		CAPACITOR: MIL type CM05EC680J03.	5-22
A2A3C1102		CAPACITOR: Same as A2A3C417.	5-22
A2A3CR100		Not Used.	
A2A3CR101		DIODE, SILICON: Mfr 06090, P/N RD5288.	5-22
A2A3CR102		DIODE: Same as A2A3CR101.	5-22
A2A3CR200		Not Used.	
A2A3CR201		DIODE: Same as A2A3CR101.	5-22
A2A3CR202		DIODE: Same as A2A3CR101.	5-22
A2A3CR300		Not Used.	
A2A3CR301		Not Used.	
A2A3CR302 to A2A3CR309		DIODES, MATCHED SET: Not separately replaceable; mfr 28480, P/N 5080-0442.	5-22
A2A3CR310 to A2A3CR312			
A2A3CR313		DIODE: Same as A1A1CR102.	5-22
A2A3CR314		DIODE: Same as A1A1CR102.	5-22
A2A3CR315		DIODE: Same as A1A1CR102.	5-22
A2A3CR316		DIODE: Same as A1A1CR102.	5-22
A2A3CR400		Not Used.	
A2A3CR401		Not Used.	
A2A3CR402 to A2A3CR409		DIODES: Same as A2A3CR302.	5-22
A2A3CR410 to A2A3Q412		Not Used.	
A2A3CR413		DIODE: Same as A1A1CR102.	5-22
A2A3CR414		DIODE: Same as A1A1CR102.	5-22
A2A3CR415		DIODE: Same as A1A1CR102.	5-22
A2A3CR416		DIODE: Same as A1A1CR102.	5-22
A2A3CR1100		Not Used.	
A2A3CR1101		DIODE: Same as A1A1CR102.	5-22

TABLE 6-1. (Continued)

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG. NO.
A2A3K1100		Not Used.	
A2A3K1101		COIL, RELAY, MAGNETIC REED: 12 vdc, 0.24w, 600 ohm; mfr 71707, P/N U-12-P	5-22
A2A3L300		Not Used.	
A2A3L301		INDUCTOR, FIXED: 0.18 uh ±10%; mfr 95265, P/N NBO-18P.	5-22
A2A3L400		Not Used.	
A2A3L401		INDUCTOR: Same as A2A3L301.	5-22
A2A3L402		INDUCTOR: Same as A1A3L203.	5-22
A2A3L403		INDUCTOR: Same as A1A3L203.	5-22
A2A3L500 to A2A3L502		Not Used.	
A2A3L503		INDUCTOR: Same as A1A3L203 (2 required).	5-22
A2A3L504		INDUCTOR: Same as A1A3L203 (2 required).	5-22
A2A3L505		Not Used.	
A2A3L506		INDUCTOR: Same as A1A1L102.	5-22
A2A3L507 to A2A3L509		Not Used.	
A2A3L510		INDUCTOR: Same as A1A1L102.	5-22
A2A3L511		INDUCTOR: Same as A1A1L102.	5-22
A2A3L512		INDUCTOR: Same as A1A1L102.	5-22
A2A3L513		INDUCTOR: Same as A1A1L102.	5-22
A2A3L514		INDUCTOR: Same as A1A1L102.	5-22
A2A3L515 to A2A3L517		Not Used.	
A2A3L518		INDUCTOR: Same as A1A1L102.	5-22
A2A3L519		INDUCTOR: Same as A1A1L102.	5-22
A2A3L520		INDUCTOR: Same as A1A1L102.	5-22
A2A3Q100		Not Used.	
A2A3Q101 and A2A3Q102		TRANSISTOR, FIELD-EFFECT, N CHAN: Matched set, includes A2A3Q102; mfr 28480, P/N 5080-0449.	5-22
A2A3Q103 and A2A3Q104		TRANSISTOR, SILICON, NPN, DUAL: Includes A2A3Q104; mfr 04713, P/N MD918.	5-22
A2A3Q200		Not Used.	
A2A3Q201 and A2A3Q202		TRANSISTOR: Same as A2A3Q101 and A2A3Q102.	5-22
A2A3Q203 and A2A3Q204		TRANSISTOR: Same as A2A3Q103 and A2A3Q104.	5-22
A2A3Q300		Not Used.	
A2A3Q301		TRANSISTOR, SILICON, PNP, Mfr 28480, P/N 1853-0026.	5-22
A2A3Q302		TRANSISTOR: Same as A2A3Q301.	5-22
A2A3Q303		TRANSISTOR, SILICON, PNP: Mfr 04713, P/N SM9105.	5-22
A2A3Q304		TRANSISTOR: Same as A2A3Q303.	5-22
A2A3Q305		TRANSISTOR, SILICON, NPN: MIL type 2N3563.	5-22
A2A3Q306		TRANSISTOR: Same as A2A3Q305.	5-22
A2A3Q307		TRANSISTOR, SILICON, NPN, Mfr 28480, P/N 1854-0019.	5-22

TABLE 6-1. (Continued)

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG. NO.
A2A3Q308		TRANSISTOR: Same as A2A3Q307.	5-22
A2A3Q400		Not Used.	
A2A3Q401		TRANSISTOR: Same as A2A3Q301.	5-22
A2A3Q402		TRANSISTOR: Same as A2A3Q301.	5-22
A2A3Q403		TRANSISTOR: Same as A2A3Q303.	5-22
A2A3Q404		TRANSISTOR: Same as A2A3Q303.	5-22
A2A3Q405		TRANSISTOR: Same as A2A3Q305.	5-22
A2A3Q406		TRANSISTOR: Same as A2A3Q305.	5-22
A2A3Q407		TRANSISTOR: Same as A2A3Q307.	5-22
A2A3Q408		TRANSISTOR: Same as A2A3Q307.	5-22
A2A3Q500		Not Used.	
A2A3Q501		TRANSISTOR: Same as A2A3Q305.	5-22
A2A3Q502		TRANSISTOR: Same as A2A3Q305.	5-22
A2A3Q503		TRANSISTOR: Same as A2A3Q305.	5-22
A2A3Q504		TRANSISTOR: Same as A2A3Q305.	5-22
A2A3Q505		TRANSISTOR, SILICON, NPN: Mfr 04713, P/N SM9104.	5-22
A2A3Q506		TRANSISTOR: Same as A2A3Q505.	5-22
A2A3Q507		TRANSISTOR: Same as A1A1Q101.	5-22
A2A3Q508		TRANSISTOR: Same as A1A1Q101.	5-22
A2A3Q700		Not Used.	
A2A3Q701		TRANSISTOR, SILICON, PNP: MIL type 2N3640.	5-22
A2A3Q702		TRANSISTOR: Same as A2A3Q701.	5-22
A2A3Q703		TRANSISTOR: Same as A2A3Q305.	5-22
A2A3Q704		TRANSISTOR: Same as A2A3Q305.	5-22
A2A3R100 to A2A3R118		Not Used.	
A2A3R119		RESISTOR: MIL type RN60C2743F.	5-22
A2A3R120		RESISTOR: Same as A1A1R104.	5-22
A2A3R121		RESISTOR: Same as A1A1R104.	5-22
A2A3R122		RESISTOR: MIL type RN60C3321F.	5-22
A2A3R123		RESISTOR: Same as A2A3R122.	5-22
A2A3R124		Not Used.	
A2A3R125		RESISTOR: MIL type RN60C1211F.	5-22
A2A3R126		RESISTOR: MIL type RN60C3010F.	5-22
A2A3R127		RESISTOR: Same as A2A3R126.	5-22
A2A3R200 to A2A3R218		Not Used.	
A2A3R219		RESISTOR: Same as A2A3R119.	5-22
A2A3R220		RESISTOR: Same as A1A1R104.	5-22
A2A3R221		RESISTOR: Same as A1A1R104.	5-22
A2A3R222		RESISTOR: Same as A2A3R122.	5-22
A2A3R223		RESISTOR: Same as A2A3R122.	5-22
A2A3R224		Not Used.	
A2A3R225		RESISTOR: Same as A2A3R125.	5-22
A2A3R226		RESISTOR: Same as A2A3R126.	5-22
A2A3R227		RESISTOR: Same as A2A3R126.	5-22
A2A3R300		Not Used.	
A2A3R301		RESISTOR: Same as A1A1R132.	5-22
A2A3R302		RESISTOR: Same as A1A1R132.	5-22
A2A3R303		RESISTOR, VARIABLE, METAL FILM: 200 ohms ±30%, 1/2w; mfr 73138, P/N 62PR200.	5-22

TABLE 6-1. (Continued)

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG. NO.
A2A3R304		RESISTOR: MIL type RN60C61R9F.	5-22
A2A3R305		RESISTOR: MIL type RN60C2430F.	5-22
A2A3R306		RESISTOR: Same as A2A3R305.	5-22
A2A3R307		RESISTOR: Same as A1A1R104.	5-22
A2A3R308		RESISTOR, VARIABLE, COMPOSITION: 20k ohms ±10%, 1/8w; mfr 28480, P/N 2100-2271.	5-22
A2A3R309		Not Used.	
A2A3R310		RESISTOR: Same as A2A1R100.	5-22
A2A3R311		RESISTOR: Same as A2A1R100.	5-22
A2A3R312 to A2A3R314		Not Used.	
A2A3R315		RESISTOR: MIL type RN60C90R9F.	5-22
A2A3R316		RESISTOR: Same as A1A3R245.	5-22
A2A3R317		RESISTOR, VARIABLE, METAL FILM: 50 ohms ±30%, 1/4w; mfr 28480, P/N 2100-2060.	5-22
A2A3R318		RESISTOR, FIXED, METAL FILM: 10 ohms ±1%, 1/8w; mfr 28480, P/N 0757-0346.	5-22
A2A3R319		RESISTOR: Same as A2A3R318.	5-22
A2A3R320		RESISTOR: Same as A1A3R251.	5-22
A2A3R321 to A2A3R323		Not Used.	
A2A3R324		RESISTOR: Same as A1A3R205.	5-22
A2A3R325		RESISTOR: Same as A1A3R205.	5-22
A2A3R326		RESISTOR: Same as A2A3R315.	5-22
A2A3R327		RESISTOR: MIL type RN60C4320F.	5-22
A2A3R328		RESISTOR: Same as A2A3R327.	5-22
A2A3R329		RESISTOR: MIL type RN60C7500F.	5-22
A2A3R330		RESISTOR: Same as A2A3R329.	5-22
A2A3R331		Not Used.	
A2A3R332		RESISTOR: Same as A2A3R327.	5-22
A2A3R333		RESISTOR: Same as A2A3R327.	5-22
A2A3R334		RESISTOR: Same as A1A3R245.	5-22
A2A3R335		RESISTOR: Same as A1A3R245.	5-22
A2A3R336		RESISTOR: MIL type RN60C4751F.	5-22
A2A3R337		RESISTOR: Same as A2A3R336.	5-22
A2A3R338 to A2A3R341		Not Used.	
A2A3R342		RESISTOR: Same as A1A3R205.	5-22
A2A3R343		RESISTOR: Same as A1A3R205.	5-22
A2A3R344		RESISTOR: Same as A2A3R305.	5-22
A2A3R345		RESISTOR: Same as A2A3R305.	5-22
A2A3R346		RESISTOR: MIL type RN60C2211F.	5-22
A2A3R347		RESISTOR: MIL type RN60C56R2F.	5-22
A2A3R348		RESISTOR, VARIABLE, METAL FILM: 100 ohms ±30%, 1/2w; mfr 73138, P/N 62PR100.	5-22
A2A3R349		Not Used.	
A2A3R350		Not Used.	
A2A3R351		RESISTOR: Same as A2A3R315.	5-22
A2A3R352		RESISTOR: MIL type RN60C9090F.	5-22
A2A3R353		RESISTOR: Same as A2A3R352.	5-22
A2A3R400		Not Used.	
A2A3R401		RESISTOR: Same as A1A1R132.	5-22

TABLE 6-1. (Continued)

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG. NO.
A2A3R402		RESISTOR: Same as A1A1R132.	5-22
A3A3R403		RESISTOR: Same as A2A3R303.	5-22
A2A3R404		RESISTOR: Same as A2A3R304.	5-22
A2A3R405		RESISTOR: Same as A2A3R305.	5-22
A2A3R406		RESISTOR: Same as A2A3R305.	5-22
A2A3R407		RESISTOR: Same as A1A1R104.	5-22
A2A3R408		RESISTOR: Same as A2A3R308.	5-22
A2A3R409		Not Used.	
A2A3R410		RESISTOR: Same as A2A1R100.	5-22
A2A3R411		RESISTOR: Same as A2A1R100.	5-22
A2A3R412 to A2A3R414		Not Used.	
A2A3R415		RESISTOR: Same as A2A3R315.	5-22
A2A3R416		RESISTOR: Same as A1A3R245.	5-22
A2A3R417		RESISTOR: Same as A2A3R317.	5-22
A2A3R418		RESISTOR: Same as A2A3R318.	5-22
A2A3R419		RESISTOR: Same as A2A3R318.	5-22
A2A3R420		RESISTOR: Same as A1A3R251.	5-22
A2A3R421 to A2A3R423		Not Used.	
A2A3R424		RESISTOR: Same as A1A3R205.	5-22
A2A3R425		RESISTOR: Same as A1A3R205.	5-22
A2A3R426		RESISTOR: Same as A2A3R315.	5-22
A2A3R427		RESISTOR: Same as A2A3R327.	5-22
A2A3R428		RESISTOR: Same as A2A3R327.	5-22
A2A3R429		RESISTOR: Same as A2A3R329.	5-22
A2A3R430		RESISTOR: Same as A2A3R329.	5-22
A2A3R431		Not Used.	
A2A3R432		RESISTOR: Same as A2A3R327.	5-22
A2A3R433		RESISTOR: Same as A2A3R327.	5-22
A2A3R434		RESISTOR: Same as A1A3R245.	5-22
A2A3R435		RESISTOR: Same as A1A3R245.	5-22
A2A3R436		RESISTOR: Same as A2A3R336.	5-22
A2A3R437		RESISTOR: Same as A2A3R336.	5-22
A2A3R438 to A2A3R441		Not Used.	
A2A3R442		RESISTOR: Same as A1A3R205.	5-22
A2A3R443		RESISTOR: Same as A1A3R205.	5-22
A2A3R444		RESISTOR: Same as A2A3R305.	5-22
A2A3R445		RESISTOR: Same as A2A3R305.	5-22
A2A3R446		RESISTOR: Same as A2A3R346.	5-22
A2A3R447		RESISTOR: Same as A2A3R347.	5-22
A2A3R448		RESISTOR: Same as A2A3R348.	5-22
A2A3R500		Not Used.	
A2A3R501		RESISTOR: MIL type RN60C47R5F.	5-22
A2A3R502		RESISTOR: Same as A2A3R501.	5-22
A2A3R503		RESISTOR: Same as A1A2R151.	5-22
A2A3R504		RESISTOR: Same as A2A3R327.	5-22
A2A3R505 to A2A3R507		Not Used.	

TABLE 6-1. (Continued)

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG. NO.
A2A3R508		RESISTOR: MIL type RN65G3320F.	5-22
A2A3R509		RESISTOR: Same as A2A3R305.	5-22
A2A3R510		RESISTOR: Same as A2A3R305.	5-22
A2A3R511		RESISTOR: MIL type RN60C3011F.	5-22
A2A3R512		RESISTOR: Same as A2A3R511.	5-22
A2A3R513		Not Used.	
to			
A2A3R515			
A2A3R516		RESISTOR: MIL type RN70C3320F.	5-22
A2A3R517		RESISTOR: Same as A2A3R516.	5-22
A2A3R518		RESISTOR: MIL type RN60C68R1F.	5-22
A2A3R519		RESISTOR: MIL type RN60C1622F.	5-22
A2A3R520		RESISTOR: Same as A2A3R352.	5-22
A2A3R521		RESISTOR: MIL type RN70C6190F.	5-22
A2A3R522		RESISTOR: Same as A2A3R521.	5-22
A2A3R523		Not Used.	
to			
A2A3R525			
A2A3R526		RESISTOR: MIL type RN70C2001F.	5-22
A2A3R527		RESISTOR: Same as A2A3R526.	5-22
A2A3R528		RESISTOR: MIL type RN70C4750F.	5-22
A2A3R529		Not Used.	
to			
A2A3R532			
A2A3R533		RESISTOR: Same as A1A1R102.	5-22
A2A3R534		RESISTOR: Same as A1A3R205.	5-22
A2A3R535		Not Used.	
to			
A2A3R539			
A2A3R540		RESISTOR: Same as A1A1R104.	5-22
A2A3R541		RESISTOR: Same as A1A1R104.	5-22
A2A3R542		RESISTOR: MIL type RN65C3012F.	5-22
A2A3R543		Not Used.	
to			
A2A3R548			
A2A3R549		RESISTOR: MIL type RN60C5620F.	5-22
A2A3R550		RESISTOR: Same as A1A3R249.	5-22
A2A3R551		RESISTOR: Same as A1A3R249.	5-22
A3A3R552		Not Used.	
A2A3R553		Not Used.	
A2A3R554		RESISTOR: Same as A2A3R550.	5-22
A2A3R555		RESISTOR: Same as A2A3R549.	5-22
A2A3R700		Not Used.	
A2A3R701		RESISTOR: Same as A1A1R102.	5-22
A2A3R702		RESISTOR: Same as A1A1R102.	5-22
A2A3R703		RESISTOR: Same as A2A3R549.	5-22
A2A3R704		RESISTOR: Same as A2A3R549.	5-22
A2A3R705		RESISTOR: MIL type RN60C6190F.	5-22
A2A3R706		RESISTOR: Same as A2A3R705.	5-22
A2A3R707		RESISTOR, VARIABLE, METAL FILM: 500 ohms ±30%, 1/2w; mfr 73138, P/N 62PR500.	5-22
A2A3R708		RESISTOR: Same as A2A3R352.	5-22
A2A3R709		RESISTOR: Same as A2A3R352.	5-22
A2A3R710		RESISTOR: MIL type RN65C1301F.	5-22

TABLE 6-1. (Continued)

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG. NO.
A2A3R711		RESISTOR: Same as A1A3R245.	5-22
A2A3R712		RESISTOR: Same as A1A3R245.	5-22
A2A3R1100		Not Used.	
A2A3R1101		RESISTOR: MIL type RN60C38R3F.	5-22
A2A3R1102		RESISTOR: Same as A1A3R249.	5-22
A2A3S1102		REED, RELAY: Mfr 95348, P/N MR306-17.	5-22
A2A3T300		Not Used.	
A2A3T301		TRANSFORMER, TORID: Mfr 28480, P/N 01801-61101.	5-22
A2A3T400		Not Used.	
A2A3T401		TRANSFORMER: Same as A2A3T301.	5-22
A2A3VR300		Not Used.	
A2A3VR301		DIODE, ZENER: 5.11 v ±5%, 400 mw; mfr 01281, P/N PS18232A.	5-22
A2A3VR400		Not Used.	
A2A3VR401		DIODE: Same as A2A3VR301.	5-22
A2A3VR500		Not Used.	
A2A3VR501		DIODE, ZENER: 30.1 v ±5%, 400 mw; mfr 04713, P/N SZ10939-320.	5-22
A2A4		CIRCUIT BOARD, OUTPUT: Printed circuit board w/all components assembled for operation; mfr 28480, P/N 01801-66508.	5-23
A2A4C500 to A2A4C513		Not Used.	
A2A4C514		CAPACITOR: Same as A1A1C102.	5-23
A2A4L500 to A2A4L506		Not Used.	
A2A4L507		INDUCTOR: Same as A1A1L102.	5-23
A2A4R500 to A2A4R542		Not Used.	
A2A4R543		RESISTOR; FIXED, WIRE WOUND: 400 ohms, ±1%, 4w; mfr 28480, P/N 0811-2070.	5-23
A2A4R544		RESISTOR: Same as A2A4R543.	5-23
A2A4R545		RESISTOR, FIXED, WIRE WOUND: 169 ohms ±1%, 4w; mfr 28480, P/N 0811-0041.	5-23
A2A5		CIRCUIT BOARD, MULTIVEBRATOR: Printed circuit board w/all components assembled for operation; mfr 28480, P/N 01801-66510.	5-24
A2A5C600		Not Used.	
A2A5C601		CAPACITOR: Same as A2A3C311.	5-24
A2A5C602		CAPACITOR: FIXED, CERAMIC: 0.01 uf +80 -20%, 100 vdcw; mfr 28480, P/N 0150-0093.	5-24
A2A5C603		CAPACITOR: Same as A2A3C311.	5-24
A2A5C604		CAPACITOR: Same as A2A5C602.	5-24
A2A5C605		CAPACITOR: Same as A2A3C308	5-24
A2A5C606		Not Used.	
A2A5C607		CAPACITOR: MIL type CM05FC121G03.	5-24
A2A5C608		CAPACITOR: Same as A2A5C607.	5-24
A2A5C609 to A2A5C611		Not Used.	
A2A5C612		CAPACITOR: Same as A2A5C602.	5-24

TABLE 6-1. (Continued)

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG. NO.
A2A5C613		CAPACITOR: Same as A2A3C307.	5-24
A2A5C614		CAPACITOR: Same as A2A3C307.	5-24
A2A5CR600		Not Used.	
A2A5CR601		DIODE: Same as A1A1CR102.	5-24
A2A5CR602		DIODE: Same as A1A1CR102.	5-24
A2A5CR603		DIODE: Same as A1A1CR102.	5-24
A2A5CR604		DIODE: Same as A1A1CR102.	5-24
A2A5CR605 to A2A5CR607		Not Used.	
A2A5CR608		DIODE: Same as A1A1CR102.	5-24
A2A5CR609		DIODE: Same as A1A1CR102.	5-24
A2A5L600		Not Used.	
A2A5L601		INDUCTOR, FIXED, MOLDED: 1 mh ±5%, 82142, P/N 19-1331-35J.	5-24
A2A5L602		INDUCTOR: Same as A2A5L601.	5-24
A2A5Q600		Not Used.	
A2A5Q601		TRANSISTOR: Same as A2A3Q701.	5-24
A2A5Q602		TRANSISTOR: Same as A2A3Q701.	5-24
A2A5Q603		TRANSISTOR: Same as A1A1Q101.	5-24
A2A5Q604		TRANSISTOR: Same as A1A1Q101.	5-24
A2A5Q605		TRANSISTOR: Same as A2A3Q305.	5-24
A2A5Q606		TRANSISTOR: Same as A2A3Q701.	5-24
A2A5R600		Not Used.	
A2A5R601		RESISTOR: Same as A1A1R125.	5-24
A2A5R602		RESISTOR: Same as A1A1R304.	5-24
A2A5R603		RESISTOR: MIL type RN60C9091F.	5-24
A2A5R604		RESISTOR: Same as A2A5R603.	5-24
A2A5R605		RESISTOR: Same as A1A1R304.	5-24
A2A5R606		RESISTOR: Same as A1A1R125.	5-24
A2A5R607		RESISTOR: Same as A1A1R116.	5-24
A2A5R608		RESISTOR: Same as A2A3R346.	5-24
A2A5R609		RESISTOR: MIL type RN60C1212F.	5-24
A2A5R610		RESISTOR: Same as A1A1R116.	5-24
A2A5R611		RESISTOR: MIL type RN65C6190F.	5-24
A2A5R612 to A2A5R614		Not Used.	
A2A5R615		RESISTOR: MIL type RN65C2000F.	5-24
A2A5R616		RESISTOR: Same as A1A1R104.	5-24
A2A5R617		RESISTOR: Same as A1A1R125.	5-24
A2A5R618		RESISTOR: Same as A1A1R131.	5-24
A2A5R619		RESISTOR: Same as A1A1R125.	5-24
A2A5R620		RESISTOR: Same as A1A1R131.	5-24
A2A5R621		RESISTOR: Same as A2A4R615.	5-24
A2A5R622		RESISTOR: Same as A1A1R104.	5-24
A2A5R623 to A2A5R625		Not Used.	
A2A5R626		RESISTOR: Same as A1A1R304.	5-24
A2A5R627		RESISTOR: Same as A1A1R304.	5-24
A2A5R628		RESISTOR: Same as A1A1R125.	5-24
A2A5R629		RESISTOR: Same as A1A1R125.	5-24
A2A5R630		RESISTOR, FIXED METAL FILM: 47.5k ohms ±1% 1/8w; mfr 28480, P/N 0757-0457.	5-24
A2A5R631		RESISTOR: Same as A1A3R259.	5-24

TABLE 6-1. (Continued)

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG. NO.
A2A5R632		RESISTOR: MIL type RN60C1502F.	5-24
A2A5R633		RESISTOR: Same as A2A5R632.	5-24
A2A6		CIRCUIT BOARD, AMPLIFIER, SYNC: Printed circuit board w/all components assembled for operation; mfr 28480, P/N 01801-66509.	5-25
A2A6C700 to A2A6C704			
A2A6C705		CAPACITOR, FIXED, CERAMIC: 220 pf ±5%, 300 vdcw; mfr 71590, P/N CBTB60-221J-Q3M.	5-25
A2A6C706		CAPACITOR: Same as A2A6C705.	5-25
A2A6C707		CAPACITOR: MIL type CM05CC821G03.	5-25
A2A6C708		CAPACITOR: MIL type CM05EC390G03.	5-25
A2A6C709 to A2A6C711		Not Used.	
A2A6C712		CAPACITOR, FIXED, ELECTROLYTIC: 10 uf -10% +75%, 25 vdcw; mfr 56829, P/N 30D106G025BB2.	5-25
A2A6C713		CAPACITOR: Same as A2A3C307.	5-25
A2A6C714		CAPACITOR: Same as A2A3C534	5-25
A2A6C715 to A2A6C717		Not Used.	
A2A6C718		CAPACITOR, FIXED, MYLAR: 3300 pf ±10%, 200 vdcw; mfr 56289, P/N 192P33292PTS.	5-25
A2A6C719		CAPACITOR: Same as A2A3C313.	5-25
A2A6C720		CAPACITOR: Same as A2A3C313.	5-25
A2A6C721		CAPACITOR: Same as A2A4C508.	5-25
A2A6C722		CAPACITOR: Same as A2A3C313.	5-25
A2A6CR700		Not Used.	
A2A6CR701		DIODE: Same as A1A1CR102.	5-25
A2A6CR702		DIODE: Same as A1A1CR102.	5-25
A2A6CR703		DIODE: Same as A1A1CR102.	5-25
A2A6CR704		DIODE: Same as A1A1CR102.	5-25
A2A6CR705		DIODE: Same as A1A1CR102.	5-25
A2A6CR706		DIODE: Same as A1A1CR102.	5-25
A2A6CR707		DIODE: Same as A1A1CR102.	5-25
A2A6CR708		DIODE: Same as A1A1CR102.	5-25
A2A6CR709		Not Used.	
A2A6CR710		DIODE: Same as A1A1CR102.	5-25
A2A6CR711		DIODE, GERMANIUM: Mfr 03877, P/N S3185G.	5-25
A2A6CR712		DIODE: Same as A1A1CR102.	5-25
A2A6CR713		DIODE: Same as A1A1CR102.	5-25
A2A6L700		Not Used.	
A2A6L701		INDUCTOR: Same as A1A1L102.	5-25
A2A6L702		INDUCTOR: Same as A1A1L102.	5-25
A2A6Q700 to A2A6Q704		Not Used.	
A2A6Q705		TRANSISTOR: Same as A2A3Q305.	5-25
A2A6Q706		TRANSISTOR: Same as A2A3Q305.	5-25
A2A6Q707		TRANSISTOR: Same as A1A1Q101.	5-25
A2A6Q708		TRANSISTOR: Same as A1A1Q101.	5-25

TABLE 6-1. (Continued)

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG. NO.
A2A6Q709		TRANSISTOR: Same as A2A3Q305.	5-25
A2A6Q710		TRANSISTOR: Same as A2A3Q305.	5-25
A2A6Q711		TRANSISTOR: Same as A2A3Q305.	5-25
A2A6Q712		TRANSISTOR: Same as A2A3Q701.	5-25
A2A6Q713		TRANSISTOR: Same as A1A1Q105.	5-25
A2A6Q714		TRANSISTOR: Same as A2A3Q305.	5-25
A2A6Q715		TRANSISTOR: Same as A2A3Q505.	5-25
A2A6Q716		TRANSISTOR: Same as A1A1Q105.	5-25
A2A6R700 to A2A6R714		Not Used.	
A2A6R715		RESISTOR, VARIABLE, WIRE WOUND: 500 ohms ±5%; mfr 28480, P/N 2100-0898.	5-25
A2A6R716		RESISTOR: Same as A1A1R127.	5-25
A2A6R717		RESISTOR: Same as A1A1R127.	5-25
A2A6R718		RESISTOR: Same as A2A3R705.	5-25
A2A6R719		RESISTOR: Same as A2A3R705.	5-25
A2A6R720		RESISTOR: Same as A2A3R352.	5-25
A2A6R721		RESISTOR: Same as A2A3R352.	5-25
A2A6R722		RESISTOR: Same as A1A3R245.	5-25
A2A6R723		RESISTOR: Same as A1A3R245.	5-25
A2A6R724 to A2A6R726		Not Used.	
A2A6R727		RESISTOR: Same as A1A1R127.	5-25
A2A6R728		RESISTOR: Same as A1A1R127.	5-25
A2A6R729		RESISTOR: Same as A2A6R715.	5-25
A2A6R730		RESISTOR, FIXED, METAL FILM: 13k ohms ±1%, 1/8w; mfr 19701, P/N MF5C-D1302F.	5-25
A2A6R731		RESISTOR: Same as A2A6R730.	5-25
A2A6R732		RESISTOR: Same as A1A1R102.	5-25
A2A6R733		RESISTOR: Same as A1A1R102.	5-25
A2A6R734		RESISTOR: MIL type RN60C36R5F.	5-25
A2A6R735		RESISTOR: Same as A1A1R104.	5-25
A2A6R736		RESISTOR: Same as A1A1R102.	5-25
A2A6R737		RESISTOR: Same as A2A3R327.	5-25
A2A6R738		RESISTOR: Same as A2A3R327.	5-25
A2A6R739		Not Used.	
A2A6R740		RESISTOR: MIL type RN60C33R2F.	5-25
A2A6R741		RESISTOR: MIL type RN70C15R0F.	5-25
A2A6R742		Not Used.	
A2A6R743		Not Used.	
A2A6R744		RESISTOR: MIL type RN60C4750F.	5-25
A2A6R745		RESISTOR: Same as A2A6R744.	5-25
A2A6R746		RESISTOR: Same as A2A3R305.	5-25
A2A6R747		RESISTOR: MIL type RN60D3920F.	5-25
A2A6R748		RESISTOR: Same as A2A3R305.	5-25
A2A6R749		RESISTOR: Same as A1A3R249.	5-25
A2A6R750		RESISTOR: MIL type RN65C1001F.	5-25
A2A6R751		RESISTOR, VARIABLE, METAL FILM: 10k ohms ±30%, 1/2w; mfr 73138, P/N 62PR10K.	5-25
A2A6R752 to A2A6R754		Not Used.	
A2A6R755		RESISTOR: Same as A1A3R247.	5-25

TABLE 6-1. (Continued)

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG. NO.
A2A6R756		RESISTOR: MIL type RN70C7500F.	5-25
A2A6R757		RESISTOR: Same as A1A1R131.	5-25
A2A6R758		RESISTOR: MIL type RN60C1820F.	5-25
A2A6R759		RESISTOR: Same as A2A3R511.	5-25
A2A6R760		RESISTOR: Same as A1A1R102.	5-25
A2A6R761		RESISTOR: Same as A2A3R318.	5-25
A2A6R762		RESISTOR: Same as A2A3R327.	5-25
A2A6R763		RESISTOR: Same as A1A1R131.	5-25
A2A6VR700		Not Used.	
A2A6VR701		DIODE, SILICON, ZENER: 10 v ±10%, 1.5w; mfr 28480, P/N 1902-0210.	5-25
A2A6VR702		DIODE, ZENER: 6.81 v ±2%, 400 mw; mfr 01281, P/N PS18244B.	5-25
A2A6VR703		DIODE: Same as A2A3VR301.	5-25
A2C100 to A2C127		Not Used.	
A2C128		CAPACITOR, FIXED, CERAMIC: 1.5 pf ±0.25 pf, 500 vdcw; mfr 72982, P/N 301-000-C0K0-159C.	5-11
A2C129		Not Used.	
A2C130		CAPACITOR: Same as A2A3C307	5-11
A2C228		CAPACITOR: MIL type CC20CK010C.	5-11
A2C229		Not Used.	
A2C230		CAPACITOR: Same as A2A3C307.	5-11
A2DL500		Not Used.	
A2DL501		DELAY LINE: 160 nsec; mfr 28480, P/N 01801-66505.	5-11
A2J1		Not Used.	
A2J2		CONNECTOR, BULKHEAD: 1 pin, male; mfr 98291, P/N 52-149-000.	5-11
A2J100		Not Used.	
A2J101		CONNECTOR, BNC: Female; mfr 95712, P/N 30624-1.	5-11
A2J201		CONNECTOR: Same as A2J101.	5-11
A2L100		Not Used.	
A2L101		INDUCTOR, FIXED: 22 uh ±10%, 640 dcma; mfr 99800, P/N 2150-32.	5-11
A2L200		Not Used.	
A2L201		INDUCTOR: Same as A2L101.	5-11
A2MP100		KNOB ASSEMBLY: Vernier volts/cm, Channel A; mfr 28480, P/N 01801-67401.	5-11
A2MP101		KNOB ASSEMBLY: Vernier volts/cm, Channel B; Same as A2MP100.	5-11
A2MP102		KNOB ASSEMBLY: Volts/cm, Channel A; mfr 28480, P/N 01801-67403.	5-11
A2MP103		KNOB ASSEMBLY: Volts/cm, Channel B; Same as A2MP102.	5-11
A2MP104		KNOB ASSEMBLY: Vertical display; mfr 28480, P/N 01801-67402.	5-11
A2MP105		KNOB ASSEMBLY: A position; mfr 28480, P/N 00180-67402.	5-11
A2MP106		KNOB ASSEMBLY: B position; Same as A1MP105.	5-11
A2MP107		KNOB; LEVER: 2 required; Same as A1MP104.	5-11
A2MP108		COUPLER, SHORT: 3 required; Same as A1MP117.	5-11
A2MP109		COUPLER, LONG: 2 required; mfr 28480, P/N 01801-23201.	5-11
A2MP110		COUPLER: 2 required; mfr 28480, P/N 5040-0218.	5-11
A2P1		CONNECTOR: 24-pin, female; mfr 28480, P/N 01801-27601.	5-11
A2P2		CONNECTOR, BOARD, VERTICAL: Mfr 28480, P/N 01801-26506.	5-11
A2Q500 to A2Q508		Not Used.	

TABLE 6-1. (Continued)

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG. NO.
A2Q509		TRANSISTOR: Same as A2A3Q505.	5-11
A2Q510		TRANSISTOR: Same as A2A3Q505.	5-11
A2Q511		TRANSISTOR: Same as A1A1Q104.	5-11
A2Q512		TRANSISTOR: Same as A1A1Q104.	5-11
A2R100 to A2R123		Not Used.	
A2R124		RESISTOR, VARIABLE, COMPOSITION: 500 ohms ±10%, 1/w; mfr 28480, P/N 2100-2062.	5-11
A2R224		RESISTOR: Same as A2R124.	5-11
A2R300 to A2R337		Not Used.	
A2R338		RESISTOR, VARIABLE, COMPOSITION: 10k ohms ±10%, 3/4w; mfr 28480, P/N 2100-2146.	5-11
A2R339 to A2R353		Not Used.	
A2R354		RESISTOR, VARIABLE, COMPOSITION: 1k ohms ±10%, 1/2w; mfr 28480, P/N 2100-2063.	5-11
A2R400 to A2R437		Not Used.	
A2R438		RESISTOR: Same as A2R338.	5-11
A2R500 to A2R528		Not Used.	
A2R529		RESISTOR: MIL type RL32S152G.	5-11
A2R530		RESISTOR: Same as A2R529.	5-11
A2R531		RESISTOR, FIXED, WIRE WOUND: 453 ohms ±1%, 3w; mfr 28480, P/N 0811-2071.	5-11
A2R532		RESISTOR: Same as A2R531.	5-11
A2R533 to A2R537		Not Used.	
A2R538		RESISTOR, FIXED, WIRE WOUND: 162 ohms ±1%, 3w; mfr 28480, P/N 0811-2069.	5-11
A2R539		RESISTOR: Same as A2R538.	5-11
A2S100		Not Used.	
A2S101		SWITCH, LEVER: 2-section, 3-position; mfr 28480, P/N 3100-1348.	5-11
A2S200		Not Used.	
A2S201		SWITCH: Same as A2S101.	5-11
A2S300		Not Used.	
A3S301		SWITCH: Same as A1S201.	5-11
A2S400		Not Used.	
A2S401		SWITCH: Same as A2S301.	5-11
A2S600		Not Used.	
A2S601		SWITCH, ROTARY: 3-section, 6-position, non-shorting; mfr 28480, P/N 3100-1350.	5-11
A2S1100		Not Used.	
A2S1101		SWITCH: Same as A2S301.	5-11
A3		TIME BASE AND DELAY OSCILLOSCOPE PLUG-IN UNIT: MIL type PL-1186/USM-281.	

TABLE 6-1. (Continued)

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG. NO.
A3A1		CIRCUIT BOARD, TRIGGER AND GATE GENERATOR: Printed circuit board w/all components assembled for operation; mfr 28480, P/N 01821-66506.	5-26
A3A1C100 to A3A1C108		Not Used.	
A3A1C109		CAPACITOR, FIXED, MYLAR: 0.01 uf +10%, 200 vdcw; mfr 56289, P/N 192P10392PTS.	5-26
A3A1C110		Not Used.	
A3A1C111		CAPACITOR: Same as A1A1C120.	5-26
A3A1C112		CAPACITOR, FIXED, CERAMIC: 1000 pf -0 +100%, 600 vdcw; mfr 28480, P/N 0160-2959.	5-26
A3A1C113		CAPACITOR: Same as A2A1C112.	5-26
A3A1C114 to A3A1C116		Not Used.	
A3A1C117		CAPACITOR: Same as A1A7C406.	5-26
A3A1C118		CAPACITOR: Same as A2A3C311.	5-26
A3A1C119		CAPACITOR: MIL type CM05ED300J03.	5-26
A3A1C120		CAPACITOR: Same as A1A1C120.	5-26
A3A1C121		CAPACITOR: Same as A2A3C311.	5-26
A3A1C122		CAPACITOR: Same as A1A1C120.	5-26
A3A1C123		CAPACITOR: Same as A1A1C120.	5-26
A3A1C200		Not Used.	
A3A1C201		CAPACITOR: Same as A2A3C311.	5-26
A3A1C202		CAPACITOR: MIL type CM05CD220J03.	5-26
A3A1C203		CAPACITOR: Same as A1A1C120.	5-26
A3A1C204		CAPACITOR, FIXED, TITANIUM: 4.7 pf ±5%, 500 vdcw; mfr 28480, P/N 0150-0042.	5-26
A3A1C205		CAPACITOR: Same as A2A3C311	5-26
A3A1C206		CAPACITOR: Same as A3A1C109.	5-26
A3A1C207		Not Used.	
A3A1C208		CAPACITOR: Same as A1A3C212.	5-26
A3A1C209		CAPACITOR: Same as A2A3C315.	5-26
A3A1300 to A3A1306		Not Used.	
A3A1C307		CAPACITOR: Same as A3A1C109.	5-26
A3A1C308		CAPACITOR: Same as A1A1C120.	5-26
A3A1C309		Not Used.	
A3A1C310		CAPACITOR: Same as A1A1C103.	5-26
A3A1C311		CAPACITOR: Same as A3A1C112.	5-26
A3A1C312		CAPACITOR: Same as A3A1C112.	5-26
A3A1C313 to A3A1C315		Not Used.	
A3A1C316		CAPACITOR: Same as A1A7C406.	5-26
A3A1C317		CAPACITOR: Same as A2A3C311.	5-26
A3A1C318		CAPACITOR: Same as A3A1C119.	5-26
A3A1C319		CAPACITOR: Same as A1A1C120.	5-26
A3A1C320		CAPACITOR: Same as A1A1C120.	5-26
A3A1C321 to A3A1C323		Not Used.	
A3A1C324		CAPACITOR: Same as A1A1C103.	5-26

TABLE 6-1. (Continued)

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG. NO.
A3A1C325		CAPACITOR: Same as A1A1C103.	5-26
A3A1C326		CAPACITOR: Same as A1A1C103.	5-26
A3A1C327		CAPACITOR, FIXED, TANTALUM, WET: 40 uf ±20%, 30 vdcw; mfr 56289, P/N 109D406X0030C2.	5-26
A3A1C328		CAPACITOR: Same as A3A1C327.	5-26
A3A1C400		Not Used.	
A3A1C401		CAPACITOR: Same as A2A3C311.	5-26
A3A1C402		CAPACITOR: Same as A3A1C202.	5-26
A3A1C403 to A3A1C412		Not Used.	
A3A1C413		CAPACITOR: Same as A3A1C119.	
A3A1C414		CAPACITOR: MIL type CM05EC600J03.	5-26
A3A1C415		CAPACITOR: Same as A1A1C103.	5-26
A3A1C416		CAPACITOR: Same as A3A1C204.	5-26
A3A1C417		CAPACITOR: Same as A2A3C311.	5-26
A3A1C418		CAPACITOR, FIXED, TITANIUM: 10 pf ±5%, 500 vdcw; mfr 28480, P/N 0150-0055.	5-26
A3A1CR100 to A3A1CR102		Not Used.	
A3A1CR103		DIODE: Same as A1A1CR115.	5-26
A3A1CR104		DIODE: Same as A2A6CR711.	5-26
A3A1CR105		DIODE: Same as A2A6CR711.	5-26
A3A1CR106		DIODE, GERMANIUM, TUNNEL: Mfr 14830, P/N MS-1064.	5-26
A3A1CR107		DIODE: Same as A1A1CR102.	5-26
A3A1CR108		DIODE: Same as A1A1CR102.	5-26
A3A1CR109		DIODE: Same as A1A1CR102.	5-26
A3A1CR110		DIODE: Same as A1A1CR102.	5-26
A3A1CR111 to A3A1CR113		Not Used.	
A3A1CR114		DIODE: Same as A1A1CR102.	5-26
A3A1CR115		DIODE: Same as A1A1CR102.	5-26
A3A1CR116		DIODE: Same as A1A1CR102.	5-26
A3A1CR117		DIODE: Same as A1A1CR102.	5-26
A3A1CR200		Not Used.	
A3A1CR201		DIODE, GERMANIUM, TUNNEL: MIL type 1N3718.	5-26
A3A1CR202		DIODE: Same as A2A6CR711.	5-26
A3A1CR203		DIODE: Same as A1A1CR102.	5-26
A3A1CR204		DIODE: Same as A1A1CR102.	5-26
A3A1CR205		DIODE: Same as A2A6CR711.	5-26
A3A1CR206		DIODE: Same as A2A6CR711.	5-26
A3A1CR207		DIODE: Same as A1A1CR102.	5-26
A3A1CR300		Not Used.	
A3A1CR301		DIODE: Same as A1A1CR115.	5-26
A3A1CR302		DIODE: Same as A2A6CR711.	5-26
A3A1CR303		DIODE: Same as A2A6CR711.	5-26
A3A1CR304		DIDOE: Same as A3A1CR106.	5-26
A3A1CR305		DIODE: Same as A1A1CR102.	5-26
A3A1CR306		DIODE: Same as A1A1CR102.	5-26
A3A1CR307		DIODE: Same as A1A1CR102.	5-26
A3A1CR308		DIODE: Same as A1A1CR102.	5-26
A3A1CR309		DIODE: Same as A1A1CR115.	5-26
A3A1CR400		Not Used.	
A3A1CR401		DIODE: Same as A3A1CR201.	5-26

TABLE 6-1. (Continued)

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG. NO.
A3A1CR402		DIODE: Same as A2A6CR711.	5-26
A3A1CR403		DIODE: Same as A1A1CR102.	5-26
A3A1CR404		DIODE: Same as A1A1CR102.	5-26
A3A1CR405		DIODE: Same as A2A6CR711.	5-26
A3A1CR406		DIODE: Same as A2A6CR711.	5-26
A3A1CR407 to A3A1CR419		Not Used.	
A3A1CR420		DIODE: Same as A2A6CR711.	5-26
A3A1CR421		DIODE: Same as A2A6CR711.	5-26
A3A1L100 to A3A1L106		Not Used.	
A3A1L107		INDUCTOR: Same as A1A1L102.	5-26
A3A1L108		INDUCTOR: Same as A1A3L203.	5-26
A3A1L109		INDUCTOR, FIXED: 0.33 uh ±5%, 200 ma; mfr 95265, P/N NBO-37PS.	5-26
A3A1L110		INDUCTOR: Same as A1A1L102.	5-26
A3A1L200		Not Used.	
A3A1L201		INDUCTOR: Same as A1A1L102.	5-26
A3A1L300		Not Used.	
A3A1L301		Not Used.	
A3A1L302		INDUCTOR: Same as A1A1L102.	5-26
A3A1L303		INDUCTOR: Same as A1A3L203.	5-26
A3A1L304		INDUCTOR: Same as A3A1L109.	5-26
A3A1L305		INDUCTOR: Same as A1A1L102.	5-26
A3A1L306		INDUCTOR: Same as A1A1L102.	5-26
A3A1Q100 to A3A1Q102		Not Used.	
A3A1Q103		TRANSISTOR: Same as A1A3Q201.	5-26
A3A1Q104		TRANSISTOR, SILICON, NPN: MIL type 2N3904.	5-26
A3A1Q105		TRANSISTOR: Same as A3A1Q104.	5-26
A3A1Q106		TRANSISTOR: Same as A1A1Q105.	5-26
A3A1Q107		TRANSISTOR, GERMANIUM, PNP: Mfr 01295, P/N GM641B.	5-26
A3A1Q108		TRANSISTOR: Same as A2A3Q307.	5-26
A3A1Q109		TRANSISTOR: Same as A1A1Q101.	5-26
A3A1Q110		TRANSISTOR, SILICON, PNP: Mfr 04713, P/N SPS4661.	5-26
A3A1Q111		TRANSISTOR: Same as A3A1Q110.	5-26
A3A1Q112		TRANSISTOR: Same as A1A1Q101.	5-26
A3A1Q200		Not Used.	
A3A1Q201		TRANSISTOR: Jan 2N964.	5-26
A3A1Q202		TRANSISTOR: Same as A1A1Q101.	5-26
A3A1Q203		TRANSISTOR, SILICON, NPN: Mfr 02195, P/N SG1294.	5-26
A3A1Q204		TRANSISTOR: Same as A1A1Q101.	5-26
A3A1Q205		TRANSISTOR: Same as A1A1Q101.	5-26
A3A1Q300		Not Used.	
A3A1Q301		TRANSISTOR: Same as A1A3Q201.	5-26
A3A1Q302		TRANSISTOR: Same as A3A1Q104.	5-26
A3A1Q303		TRANSISTOR: Same as A3A1Q104.	5-26
A3A1Q304		TRANSISTOR: Same as A1A1Q105.	5-26
A3A1Q305		TRANSISTOR: Same as A3A1Q107.	5-26
A3A1Q306		TRANSISTOR: Same as A2A3Q307.	5-26

TABLE 6-1. (Continued)

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG. NO.
A3A1Q400		Not Used.	
A3A1Q401		TRANSISTOR: Same as A3A1Q201.	5-26
A3A1Q402		TRANSISTOR: Same as A1A1Q101.	5-26
A3A1Q403		TRANSISTOR: Same as A1A1Q101.	5-26
A3A1Q404		TRANSISTOR: Same as A1A1Q101.	5-26
A3A1R100		Not Used.	
A3A1R101		RESISTOR: Same as A1A1R114.	5-26
A3A1R102		RESISTOR: Same as A1A1R114.	5-26
A3A1R103 to A3A1R116		Not Used.	
A3A1R117		RESISTOR: Same as A1A1R318.	5-26
A3A1R118		RESISTOR: Same as A2A3R347.	5-26
A3A1R119		RESISTOR: Same as A1A3R245.	5-26
A3A1R120		RESISTOR, FIXED, WIRE WOUND: 15k ohms ±3%, 3w; mfr 28480, P/N 0812-0051.	5-26
A3A1R121		Not Used.	
A3A1R122		RESISTOR: Same as A2A3R519.	5-26
A3A1R123		Not Used.	
A3A1R124		RESISTOR: Same as A1A1R114.	5-26
A3A1R125		RESISTOR: Same as A1A1R116.	5-26
A3A1R126		RESISTOR, FIXED, WIRE WOUND: 10k ohms ±1%, 3w; mfr 28480, P/N 0811-1551.	5-26
A3A1R127		RESISTOR, VARIABLE, METAL FILM: 5k ohms ±30%, 1/2w; mfr 73138, P/N 62-97-0.	5-26
A3A1R128		Not Used.	
A3A1R129		Not Used.	
A3A1R130		RESISTOR: Same as A2A3R318.	5-26
A3A1R131		RESISTOR: MIL type RN60C43R2F.	5-26
A3A1R132		RESISTOR: Same as A2A1R100.	5-26
A3A1R133		RESISTOR: Same as A1A3R204.	5-26
A3A1R134		RESISTOR: Same as A1A1R132.	5-26
A3A1R135		RESISTOR: Same as A2A3R327.	5-26
A3A1R136		RESISTOR: Same as A1A3R151.	5-26
A3A1R137		RESISTOR: Same as A1A3R259.	5-26
A3A1R138		RESISTOR: Same as A1A3R205.	5-26
A3A1R139		RESISTOR: Same as A1A3R235.	5-26
A3A1R140		RESISTOR: Same as A1A1R304.	5-26
A3A1R141		RESISTOR: MIL type RN60C6810F.	5-26
A3A1R142 to A3A1R144		Not Used.	
A3A1R145		RESISTOR: Same as A1A3R263.	5-26
A3A1R146		RESISTOR: MIL type RN60C4753F.	5-26
A3A1R147		RESISTOR: Same as A2A3R327.	5-26
A3A1R148		RESISTOR: Same as A1A1R127.	5-26
A3A1R149		RESISTOR: Same as A1A1R131.	5-26

TABLE 6-1. (Continued)

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG. NO.
A3A1R150		RESISTOR: Same as A1A1R129.	5-26
A3A1R151		RESISTOR: Same as A1A1R104.	5-26
A3A1R152		RESISTOR: Same as A1A3R259.	5-26
A3A1R153		RESISTOR: Same as A1A1R116.	5-26
A3A1R154		RESISTOR: Same as A3A1R141.	5-26
A3A1R155		RESISTOR: Same as A2A5R609.	5-26
A3A1R156		RESISTOR: Same as A2A3R511.	5-26
A3A1R200		Not Used.	
A3A1R201		RESISTOR: Same as A1A3R247.	5-26
A3A1R202		RESISTOR: Same as A1A3R235.	5-26
A3A1R203		RESISTOR: Same as A1A1R104.	5-26
A3A1R204		RESISTOR: Same as A2A3R125.	5-26
A3A1R205		RESISTOR: Same as A2A3R511.	5-26
A3A1R206		RESISTOR, FIXED, METAL FILM: 24k ohms ±5%, 1/2w; mfr 28480, P/N 0758-0073.	5-26
A3A1R207		RESISTOR: Same as A1A1R128.	5-26
A3A1R208		RESISTOR: Same as A2A3R511.	5-26
A3A1R209		RESISTOR: Same as A2A3R327.	5-26
A3A1R210		RESISTOR: Same as A2A3R327.	5-26
A3A1R211		RESISTOR: Same as A1A2R155.	5-26
A3A1R212 to A3A1R214		Not Used.	
A3A1R215		RESISTOR: MIL type RN60C1823F.	5-26
A3A1R216		RESISTOR: MIL type RN60C2742F.	5-26
A3A1R217		RESISTOR: Same as A3A1R146.	5-26
A3A1R218		RESISTOR: Same as A1A1R132.	5-26
A3A1R219		RESISTOR: MIL type RN60C2740F.	5-26
A3A1R220		RESISTOR: Same as A1A1R105.	5-26
A3A1R221		RESISTOR: MIL type RN60C1103F.	5-26
A3A1R222		RESISTOR: Same as A1A1R129.	5-26
A3A1R223		RESISTOR: MIL type RN70C1622F.	5-26
A3A1R224		RESISTOR: Same as A1A1R104.	5-26
A3A1R225		RESISTOR: Same as A1A1R304.	5-26
A3A1R226		RESISTOR: Same as A1A1R318.	5-26
A3A1R227		RESISTOR: Same as A1A1R125.	5-26
A3A1R228		RESISTOR: Same as A1A1R116.	5-26
A3A1R229		RESISTOR: MIL type RN65C4752F.	5-26
A3A1R300 to A3A1R306		Not Used.	
A3A1R307		RESISTOR: Same as A1A1R318.	5-26
A3A1R308		RESISTOR: Same as A2A3R347.	5-26
A3A1R309		RESISTOR: Same as A1A3R245.	5-26
A3A1R310		RESISTOR: Same as A3A1R120.	5-26
A3A1R311		RESISTOR: Same as A1A1R104.	5-26
A3A1R312		RESISTOR: Same as A3A1R126.	5-26
A3A1R313		Not Used.	
A3A1R314		RESISTOR: Same as A2A3R519.	5-26
A3A1R315		RESISTOR: Same as A1A1R114.	5-26
A3A1R316		Not Used	
A3A1R317		RESISTOR: Same as A1A1R116.	5-26
A3A1R318		RESISTOR, VARIABLE, CERMET FILM: 5k ohms ±30%, 1/2w; mfr 28480, P/N 2100-2216.	5-26

TABLE 6-1. (Continued)

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG. NO.
A3A1R319		Not Used.	
A3A1R320		Not Used.	
A3A1R321		RESISTOR: Same as A3A1R130.	5-26
A3A1R322		RESISTOR: Same as A3A1R131.	5-26
A3A1R323		RESISTOR: Same as A2A1R100.	5-26
A3A1R324		RESISTOR: Same as A1A3R204.	5-26
A3A1R325		RESISTOR: Same as A1A1R132.	5-26
A3A1R326		RESISTOR: Same as A2A3R327.	5-26
A3A1R327		RESISTOR: Same as A1A2R151.	5-26
A3A1R328		RESISTOR: Same as A1A1R304.	5-26
A3A1R329		RESISTOR: Same as A1A3R259.	5-26
A3A1R330		RESISTOR: Same as A1A3R205.	5-26
A3A1R331		RESISTOR: Same as A1A3R205.	5-26
A3A1R332		RESISTOR: Same as A1A3R235.	5-26
A3A1R333		RESISTOR: Same as A1A1R304.	5-26
A3A1R334		Not Used.	
A3A1R335		Not Used.	
A3A1R336		RESISTOR: Same as A1A1R104.	5-26
A3A1R337		RESISTOR: Same as A1A1R104.	5-26
A3A1R338		RESISTOR: Same as A1A1R104.	5-26
A3A1R339		RESISTOR: Same as A1A1R139.	5-26
A3A1R340		RESISTOR: Same as A1A1R139.	5-26
A3A1R400		Not Used.	
A3A1R401		RESISTOR: Same as A1A3R247.	5-26
A3A1R402		RESISTOR: Same as A1A3R235.	5-26
A3A1R403		RESISTOR: Same as A1A1R104.	5-26
A3A1R404		RESISTOR: Same as A2A3R511.	5-26
A3A1R405		RESISTOR: Same as A1A1R128.	5-26
A3A1R406		RESISTOR: Same as A3A1R206.	5-26
A3A1R407		RESISTOR: Same as A3A1R131.	5-26
A3A1R408		RESISTOR: MIL type RN60C1301F.	5-26
A3A1R409		RESISTOR: Same as A2A3R511.	5-26
A3A1R410		RESISTOR: Same as A1A1R318.	5-26
A3A1R411		RESISTOR: Same as A1A2R155.	5-26
A3A1R412		RESISTOR: Same as A2A3R327.	5-26
A3A1R413		RESISTOR: MIL type RN60C3650F.	5-26
A3A1R414 to A3A1R440		Not Used.	
A3A1R441		RESISTOR: Same as A1A1R127.	5-26
A3A1R442		RESISTOR: Same as A3A1R221.	5-26
A3A1R443		RESISTOR: Same as A1A1R129.	5-26
A3A1R444		RESISTOR: Same as A3A1R223.	5-26
A3A1R445		RESISTOR: Same as A1A1R104.	5-26
A3A1R446		RESISTOR: Same as A2A3R125.	5-26
A3A1R447		RESISTOR: Same as A2A5R603.	5-26
A3A1R448		RESISTOR: Same as A1A1R318.	5-26
A3A1V200		Not Used.	
A3A1V201		LAMP: Same as A1A1V301.	5-26
A3A1VR100		Not Used.	
A3A1VR101		DIODE, ZENER: 9.09 v ±2%, 400 mw; mfr 01281, P/N PS182568.	5-26
A3A1VR102		DIODE: Same as A2A6VR702.	5-26
A3A1VR300		Not Used.	

TABLE 6-1. (Continued)

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG. NO.
A3A1VR301		DIODE: Same as A3A1VR101.	5-26
A3A2		CIRCUIT BOARD, SWEEP GENERATOR: Printed circuit board w/all components assembled for operation; mfr 28480, P/N 01821-66505.	5-27
A3A2C100		CAPACITOR: MIL type CM05FC221503.	5-27
A3A2C101		Not Used.	
A3A2C102		CAPACITOR: Same as A1A1C120.	5-27
A3A2C103		CAPACITOR: Same as A3A1C202.	5-27
A3A2C104		CAPACITOR: Same as A1A1C120.	5-27
A3A2C105		Not Used.	
A3A2C106		Not Used.	
A3A2C107		CAPACITOR: Same as A2A3C313.	5-27
A3A2C200 to A3A2C210		Not Used.	
A3A2C211		CAPACITOR: Same as A2A3C508.	5-27
A3A2C212		Not Used.	
A3A2C213		CAPACITOR: Same as A1A1C103.	5-27
A3A2C214		CAPACITOR: Same as A1A1C120.	5-27
A3A2C215		CAPACITOR: Same as A1A1C103.	5-27
A3A2C216		CAPACITOR: Same as A1A1C103.	5-27
A3A2C217		CAPACITOR: Same as A3A1C119.	5-27
A3A2C218		CAPACITOR: MIL type CM061C152G03.	5-27
A3A2C219		CAPACITOR: MIL type CC20CH180G.	5-27
A3A2C220		CAPACITOR: Same as A1A1C103.	5-27
A3A2C400 to A3A2C402		Not Used.	
A3A2C403		CAPACITOR: Same as A1A1C103.	5-27
A3A2C404		CAPACITOR: Same as A1A1C103.	5-27
A3A2C405		CAPACITOR: Same as A1A1C103.	5-27
A3A2C406		CAPACITOR: Same as A3A1C119.	5-27
A3A2C407		CAPACITOR: Same as A3A2C218.	5-27
A3A2C408		CAPACITOR: MIL type CM05EC390J03.	5-27
A3A2C409		CAPACITOR: Same as A1A1C103.	5-27
A3A2C410 to A3A2C418		Not Used.	
A3A2C419		CAPACITOR: Same as A1A1C103.	5-27
A3A2C420		CAPACITOR: Same as A1A1C120.	5-27
A3A2C421		CAPACITOR: Same as A1A1C120.	5-27
A3A2C422		CAPACITOR: Same as A3A1C202.	5-27
A3A2C423		CAPACITOR: Same as A1A7C406.	5-27
A3A2C424		CAPACITOR: Same as A1A1C103.	5-27
A3A2C425		CAPACITOR, FIXED, ELECTROLYTIC: 25 uf -10%, +75%, 12 vdcw; mfr 56289, P/N 30D256G012BB2-DSM.	5-27 5-27
A3A2C426		CAPACITOR: MIL type CSR136126KM.	5-27
A3A2C500		Not Used.	
A3A2C501		Not Used.	
A3A2C502		CAPACITOR, FIXED, POLYSTRENE: 0.1 uf ±5%, 100 vdcw; mfr 01281, P/N 863T10451W2.	5-27
A3A2C503		CAPACITOR, FIXED, POLYSTRENE: 0.01 uf ±5%, 100 vdcw; mfr 56289, P/N 490P10351.	5-27

TABLE 6-1. (Continued)

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG. NO.
A3A2C504		CAPACITOR, FIXED, POLYSTRENE: 0.001 uf ±5%, 100 vdcw; mfr 56289, P/N 490P10251.	5-27
A3A2C505		CAPACITOR: MIL type CM05EC800G03.	5-27
A3A2C506		CAPACITOR: Same as A2A3C507.	5-27
A3A2C507		CAPACITOR: MIL type CM05EC430J03.	5-27
A3A2C508		CAPACITOR: Same as A2A3C507.	5-27
A3A2C509		CAPACITOR: MIL type CC20CH200G.	5-27
A3A2C510		CAPACITOR: Same as A2A3C501.	5-27
A3A2C511 to A3A2C523		Not Used.	
A3A2C524		CAPACITOR: Same as A3A2C502.	5-27
A3A2C525		CAPACITOR: Same as A3A2C503.	5-27
A3A2C526		CAPACITOR: Same as A3A2C504.	5-27
A3A2C527		CAPACITOR: Same as A3A2C505.	5-27
A3A2C528		CAPACITOR: Same as A2A3C507.	5-27
A3A2C529		CAPACITOR: Same as A3A2C507.	5-27
A3A2C530		CAPACITOR: Same as A2A3C507.	5-27
A3A2C531		CAPACITOR: Same as A3A2C219.	5-27
A3A2C532		CAPACITOR: Same as A2A3C501.	5-27
A3A2CR200 to A3A2CR209		Not Used.	
A3A2CR210		DIODE: Same as A1A1CR102.	5-27
A3A2CR211		DIODE, SILICON: Mfr 03877, P/N SG5526.	5-27
A3A2CR212		DIODE: Same as A1A1CR115.	5-27
A3A2CR213		DIODE: Same as A1A1CR102.	5-27
A3A2CR214		DIODE: Same as A1A1CR102.	5-27
A3A2CR215		DIODE, SILICON: Mfr 03877, P/N SG5140.	5-27
A3A2CR216		DIODE: Same as A1A1CR102.	5-27
A3A2CR217		DIODE: Same as A1A1CR102.	5-27
A3A2CR218		DIODE: Same as A1A1CR102.	5-27
A3A2CR219		DIODE: Same as A1A1CR102.	5-27
A3A2CR220		DIODE: Same as A1A1CR115.	5-27
A3A2CR400 to A3A2CR409		Not Used.	
A3A2CR410		DIODE: Same as A1A1CR102.	5-27
A3A2CR411		DIODE: Same as A3A2CR211.	5-27
A3A2CR412		DIODE: Same as A1A1CR102.	5-27
A3A2CR413		DIODE: Same as A3A2CR215.	5-27
A3A2CR414		DIODE: Same as A1A1CR115.	5-27
A3A2CR415		DIODE: Same as A1A1CR102.	5-27
A3A2CR416		DIODE: Same as A1A1CR102.	5-27
A3A2CR417 to A3A2CR421		Not Used.	
A3A2CR422		DIODE: Same as A1A1CR102.	5-27
A3A2CR423		DIODE, TUNNEL: MIL type 1N3714.	5-27
A3A2CR424		DIODE: Same as A1A1CR102.	5-27
A3A2CR425		DIODE: Same as A1A1CR102.	5-27
A3A2L100		Not Used.	
A3A2L101		INDUCTOR: Same as A1A3L203.	5-27
A3A2L102		INDUCTOR: Same as A1A1L102.	5-27
A3A2L103		INDUCTOR: Same as A1A1L102.	5-27

TABLE 6-1. (Continued)

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG. NO.
A3A2L200 to A3A2L202		Not Used.	
A3A2L203		INDUCTOR: Same as A1A3L203.	5-27
A3A2L400		Not Used.	
A3A2L401		Not Used.	
A3A2L402		INDUCTOR: Same as A1A3L203.	5-27
A3A2Q100		Not Used.	
A3A2Q101		TRANSISTOR:, SILICON, NPN: Mfr 04713, P/N MPS6543.	5-27
A3A2Q102		TRANSISTOR: SILICON, PNP: Mil type 2N3906.	5-27
A3A2Q200 to A3A2Q205		Not Used.	
A3A2Q206		TRANSISTOR: Same as A3A2Q102.	5-27
A3A2Q207		TRANSISTOR: Same as A1A3Q201.	5-27
A3A2Q208		TRANSISTOR, SILICON, NPN: MIL type 2N3904.	5-27
A3A2Q209		TRANSISTOR, SILICON, NPN: Mfr 01295, P/N SG1294.	5-27
A3A2Q210		TRANSISTOR: Same as A3A2Q208.	5-27
A3A2Q211		TRANSISTOR: Same as A3A2Q208.	5-27
A3A2Q400 to A3A2Q404		Not Used.	
A3A2Q405		TRANSISTOR: Same as A3A2Q102.	5-27
A3A2Q406		TRANSISTOR: Same as A1A3Q201.	5-27
A3A2Q407		TRANSISTOR: Same as A3A2Q208.	5-27
A3A2Q408		TRANSISTOR: Same as A3A2Q209.	5-27
A3A2Q409		TRANSISTOR: Same as A1A1Q101.	5-27
A3A2Q410		TRANSISTOR: Same as A1A3Q203.	5-27
A3A2Q411		TRANSISTOR: Same as A3A2Q209.	5-27
A3A2Q412		TRANSISTOR: Same as A1A3Q201.	5-27
A3A2Q413		TRANSISTOR: Same as A3A2Q209.	5-27
A3A2R100 to A3A2R104		Not Used.	
A3A2R105		RESISTOR: Same as A1A1R139.	5-27
A3A2R106		RESISTOR: Same as A1A1R129.	5-27
A3A2R107		RESISTOR: Same as A1A1R104.	5-27
A3A2R108		RESISTOR: Same as A2A3R347.	5-27
A3A2R109		RESISTOR: Same as A2A3R318.	5-27
A3A2R110		RESISTOR: Same as A1A1R125.	5-27
A3A2R111		RESISTOR: Same as A1A1R102.	5-27
A3A2R200 to A3A2R231		Not Used.	
A3A2R232		RESISTOR: Same as A1A1R129.	5-27
A3A2R233		RESISTOR: Same as A2A3R549.	5-27
A3A2R234		RESISTOR, FIXED, COMPOSITION: 22 ohms ±5%, 1/4w; mfr 01121, P/N CB2205.	5-27
A3A2R235		Not Used.	
A3A2R236		Not Used.	
A3A2R237		RESISTOR: Same as A1A3R245.	5-27
A3A2R238		RESISTOR: Same as A1A3R250.	5-27
A3A2R239		RESISTOR: Same as A1A3R251.	5-27
A3A2R240		RESISTOR: Same as A3A1R141.	5-27

TABLE 6-1. (Continued)

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG. NO.
A3A2R241		RESISTOR: Same as A1A3R234.	5-27
A3A2R242 to A3A2R244		Not Used.	
A3A2R245		RESISTOR: Same as A3A2R234.	5-27
A3A2R246		RESISTOR: Same as A1A1R127.	5-27
A3A2R247		RESISTOR: MIL type RN60C1620F.	5-27
A3A2R248		RESISTOR: Same as A1A3R259.	5-27
A3A2R249		RESISTOR: Same as A2A3R305.	5-27
A3A2R250		RESISTOR: MIL type RN60C6811F.	5-27
A3A2R251		RESISTOR, VARIABLE, WIRE WOUND: 2.5k ohms ±5%, 1w; mfr 28480, P/N 2100-1451.	5-27
A3A2R252		RESISTOR: Same as A1A3R204.	5-27
A3A2R253		RESISTOR: Same as A3A2R234.	5-27
A3A2R254		RESISTOR: Same as A3A1R146.	5-27
A3A2R255		RESISTOR: Same as A3A1R215.	5-27
A3A2R256		RESISTOR: Same as A1A1R129.	5-27
A3A2R257		RESISTOR: Same as A1A1R116.	5-27
A3A2R400 to A3A2R416		Not Used.	
A3A2R417		RESISTOR: Same as A2A3R549.	5-27
A3A2R418		RESISTOR: Same as A1A1R129.	5-27
A3A2R419		RESISTOR: Same as A3A2R234.	5-27
A3A2R420		Not Used.	
A3A2R421		Not Used.	
A3A2R422		RESISTOR: Same as A1A3R250.	5-27
A3A2R423		RESISTOR: Same as A1A3R251.	5-27
A3A2R424		RESISTOR: Same as A3A1R141.	5-27
A3A2R425		RESISTOR: Same as A1A3R234.	5-27
A3A2R426 to A3A2R428		Not Used.	
A3A2R429		RESISTOR: Same as A3A2R234.	5-27
A3A2R430		RESISTOR: Same as Q1A1R127.	5-27
A3A2R431		RESISTOR: Same as A3A2R247.	5-27
A3A2R432		RESISTOR: Same as A1A3R259.	5-27
A3A2R433		RESISTOR: Same as A2A3R305.	5-27
A3A2R434		RESISTOR: Same as A3A2R250.	5-27
A3A2R435		RESISTOR: Same as A3A2R251.	5-27
A3A2R436		RESISTOR: Same as A1A3R204.	5-27
A3A2R437		RESISTOR: Same as A3A2R234.	5-27
A3A2R438 to A3A2R448		Not Used.	
A3A2R449		RESISTOR: MIL type RC07GF100J.	5-27
A3A2R450		RESISTOR: Same as A1A3R245.	5-27
A3A2R451 to A3A2R453		Not Used.	
A3A2R454		RESISTOR: Same as A1A1R125.	5-27
A3A2R455		RESISTOR: Same as A1A1R125.	5-27
A3A2R456		RESISTOR: Same as A2A3R511.	5-27
A3A2R457		RESISTOR: Same as A2A3R511.	

TABLE 6-1. (Continued)

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG. NO.
A3A2R458		RESISTOR: Same as A2A5R603.	5-27
A3A2R459		RESISTOR: Same as A1A1R125.	5-27
A3A2R460		RESISTOR: Same as A1A1R104.	5-27
A3A2R461		RESISTOR: Same as A1A3R259.	5-27
A3A2R462		RESISTOR: Same as A1A1R104.	5-27
A3A2R463		RESISTOR: Same as A3A2R250.	5-27
A3A2R464		RESISTOR: Same as A1A1R129.	5-27
A3A2R465 to A3A2R467		Not Used.	
A3A2R468		RESISTOR: MIL type RN60C3652F.	5-27
A3A2R469		RESISTOR, VARIABLE, WIRE WOUND: 15k ohms ±5%, 1w; mfr 28480, P/N 2100-0896.	5-27
A3A2R470		RESISTOR: Same as A1A2R149.	5-27
A3A2R471		Not Used,	
A3A2R472		RESISTOR: Same as A2A3R549.	5-27
A3A2R473		RESISTOR: Same as A1A7R427.	5-27
A3A2R474		RESISTOR: Same as A2A3R126.	5-27
A3A2R500 to A3A2R512		Not Used.	
A3A2R513		RESISTOR, VARIABLE, WIRE WOUND: 20k ohms ±10%, 1/2w; mfr 28480, P/N 2100-1777.	5-27
A3A2R514		RESISTOR: Same as A3A2R513.	5-27
A3A2R515		RESISTOR: Same as A3A2R513.	5-27
A3A2R516		RESISTOR: Same as A3A2R513.	5-27
A3A2R517		RESISTOR: Same as A1A1R128.	5-27
A3A2R518		RESISTOR: Same as A2A5R603.	5-27
A3A2R519		RESISTOR: Same as A1A3R204.	5-27
A3A2R520 to A3A2R536		Not Used.	
A3A2R537		RESISTOR: Same as A3A2R513.	5-27
A3A2R538		RESISTOR: Same as A3A2R513.	5-27
A3A2R539		RESISTOR: Same as A3A2R513.	5-27
A3A2R540		RESISTOR: Same as A1A2R151.	5-27
A3A2R541		RESISTOR: Same as A2A3R336.	5-27
A3A2R542		RESISTOR: Same as A1A3R204.	5-27
A3A2VR100		DIODE: Same as A3A2VR301.	5-27
A3A2VR200		Not Used.	
A3A2VR201		DIODE, ZENER: 56.2 v ±10%, 1.5w; mfr 28480, P/N 1902-0214.	5-27
A3A2VR400		Not Used.	
A3A2VR401		DIODE, ZENER: 30.9 v ±2%, mfr 04713, P/N SZ10939-324.	5-27
A3A2VR402		DIODE: Same as A3A2VR401.	5-27
A3A2VR403		DIODE: Same as A3A2VR201.	5-27
A3A3		SWITCH ASSEMBLY, SWEEP TIME: Rotary switch w/all components assembled for operation; mfr 28480, P/N 01821-61903.	5-28
A3A3C200 to A3A3C206		Not Used.	
A3A3C207		CAPACITOR: Same as A1A7C406.	5-28

TABLE 6-1. (Continued)

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG. NO.
A3A3C500		Not Used.	
A3A3C501		CAPACITOR, FIXED, POLYSTYRENE: 1.0 uf ±5%, 100 vdcw; mfr 01281, P/N 863T105512.	5-28
A3A3C502 to A3A3C513		Not Used.	
A3A3C514		CAPACITOR: Same as A1A1C120.	5-28
A3A3C515		CAPACITOR: Same as A1A3C228.	5-28
A3A3C516		CAPACITOR: Same as A1A7C413.	5-28
A3A3C517		CAPACITOR, FIXED, MYLAR: 1800 pf ±10%, 200 vdcw; mfr 56289, P/N 192P18292-PTS.	5-28
A3A3C518		CAPACITOR, FIXED, CERAMIC:: 200 pf ±5%, 500 vdcw; mfr 56289, P/N 40C81A2.	5-28
A3A3C519		CAPACITOR, FIXED, CERAMIC: 100 pf ±10%, 500 vdcw; mfr 56289, P/N 40C200A2.	5-27
A3A3C520		CAPACITOR, FIXED, CERAMIC: 56 pf ±10%, 1000 vdcw; mfr 56289, P/N 40C130A2.	5-28
A3A3C600		Not Used.	
A3A3C601		CAPACITOR: Same as A1A1C120.	5-28
A3A3CR500		Not Used.	5-28
A3A3CR501		DIODE: Same as A1A1CR115.	5-28
A3A3CR502		DIODE: Same as A1A1CR102.	5-28
A3A3L200		Not Used.	
A3A3L201		Not Used.	
A3A3L202		INDUCTOR: Same as A2L101.	5-28
A3A3L600		Not Used.	
A3A3L601		INDUCTOR: Same as A2L101.	5-28
A3A3L602		INDUCTOR: Same as A2L101.	5-28
A3A3R500		RESISTOR, FIXED, METAL FILM: 30 megohms ±1%, 1/2w; mfr 03888, P/N RN70D3005F.	5-28
A3A3R501		Not Used.	
A3A3R502		RESISTOR: MIL type RN70C1505F.	5-28
A3A3R503		RESISTOR: MIL type RN70C9004D.	5-28
A3A3R504		RESISTOR: MIL type RN70C6004D.	5-28
A3A3R505		RESISTOR, FIXED, METAL FILM: 1.5 megohms ±0.1%, 1/2w; mfr 28480, P/N 0698-5498.	5-28
A3A3R506		RESISTOR: Same as A3A3R505.	5-28
A3A3R507		RESISTOR, FIXED, METAL FILM: 600k ohms ±0.1%, 1/2w; mfr 19701, P/N MF7C-C6003B.	5-28
A3A3R508		RESISTOR: MIL type RN50D2553B.	5-28
A3A3R509		RESISTOR: Same as A3A3R508.	5-28
A3A3R510		RESISTOR: MIL type RN60D1023B.	5-28
A3A3R511 to A3A3R520		Not Used.	
A3A3R521		RESISTOR: Same as A1A7R405.	5-28
A3A3R522		RESISTOR: Same as A1A1R304.	5-28
A3A3R523		RESISTOR: Same as A1A1R331.	5-28
A3A3R524		Not Used.	
A3A3R525		Not Used.	
A3A3R526		RESISTOR: Same as A3A3R503.	5-28
A3A3R527		RESISTOR: Same as A3A3R504.	5-28
A3A3R528		RESISTOR: Same as A3A3R505.	5-28
A3A3R529		RESISTOR: Same as A3A3R505.	5-28

TABLE 6-1. (Continued)

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG. NO.
A3A3R530		RESISTOR: Same as A3A3R507.	5-28
A3A3R531		RESISTOR: Same as A3A3R508.	5-28
A3A3R532		RESISTOR: Same as A3A3R508.	5-28
A3A3R533		RESISTOR: Same as A3A3R510.	5-28
A3A3S500		Not Used.	
A3A3S501		SWITCH, ROTARY: 5-section, 23-position, non -shorting;mfr 28480, P/N 2100-1369.	5-28
A3A3S502		SWITCH, ROTARY: 2-section, 3-position; mfr 28480, P/N 3100-1349.	5-28
A3A3S503		SWITCH: Part of A3A3S501, 4-section, 19-position.	5-28
A3C100		Not Used..	
A3C101		CAPACITOR: Same as A2A1C119.	5-12
A3C102 to A3C104		Not Used.	
A3C105		CAPACITOR: Same as A2A3C129.	5-12
A3C106		CAPACITOR, FIXED, CERAMIC: 100 pf, 600 vdcw; mfr 28480, P/N 0150-0051.	5-12
A3C300		Not Used.	
A3C301		CAPACITOR: MIL type CC20CK1R8C.	5-12
A3C302		CAPACITOR: Same as A2A3C129.	5-12
A3C303		CAPACITOR: Same as A3C106.	5-12
A3DS200		Not Used.	
A3DS201		LAMP, SWITCH, PUSHBUTTON: Part of A3S201, Not separately replaceable.	5-12
A3J1		CONNECTOR, RECEPTACLE, RANK AND PANEL: 24-contact; mfr 71785, P/N 26-4200-24S.	5-12
A3J100		Not Used.	
A3J101		CONNECTOR: Same as A1J101.	
A3J300		Not Used.	
A3J301		CONNECTOR: Same as A1J101.	5-12
A3J400		Not Used.	
A3J401		CONNECTOR: Same as A1J101.	5-12
A3L100 to A3L103		Not Used.	
A3L104		INDUCTOR: Same as A1A3L203.	5-12
A3L300		Not Used.	
A3L301		INDUCTOR: Same as A1A3L203.	5-12
A3MP100		KNOB ASSEMBLY: Delayed vernier; mfr 28480, P/N 01821-67403.	5-12
A3MP101		KNOB ASSEMBLY: Main vernier; Same as A3MP100.	5-12
A3MP102		KNOB ASSEMBLY: Delayed trigger level; mfr 28480, P/N 01821-67401.	5-12
A3MP103		KNOB ASSEMBLY: Main trigger level; Same as A3MP102.	5-12
A3MP104		KNOB ASSEMBLY: Delayed time/cm; mfr 28480, P/N 0370-0341.	5-12
A3MP105		BRACKET, SWEEP, DIAL: Mfr 28480, P/N 01821-01205.	5-12
A3MP106		DIAL, Sweep: Mfr 28480, P/N 01821-04002.	5-12
A3MP107		KNOB ASSEMBLY: Main time/cm; mfr 28480, P/N 0370-0342.	5-12
A3MP108		KNOB ASSEMBLY: Sweep display; mfr 28480, P/N 01821-67402.	5-12
A3MP109		DIAL, 10-TURN: Mfr 75042, P/N RD461.	5-12

TABLE 6-1. (Continued)

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG. NO.
A3MP110		KNOB, LEVER: 7 required; Same as A1MP104.	5-12
A3P1		CONNECTOR, PLUG, RACK AND PANEL: 32-contact, mfr 02660, P/N 26-2100-32P.	5-12
A3P2		CONNECTOR BULKHEAD: 1-pin, female; mfr 98291, P/N 52-146-0000.	5-12
A3R100 to A3R102		Not Used.	
A3R103		RESISTOR: MIL type RN60C9003K.	5-12
A3R104		RESISTOR: Same as A3A1R221.	5-12
A3R105 to A3R111		Not Used.	
A3R112		RESISTOR: Same as A1A3R202.	5-12
A3R113		RESISTOR: Same as A1A1R318.	5-12
A3R114		RESISTOR: Same as A1A1R318.	
A3R115 to A3R120		Not Used.	
A3R121		RESISTOR, VARIABLE, COMPOSITION: 5k ohms ±10%, 1/4w; mfr 28480, P/N 2100-2001.	5-12
A3R200 to A3R234		Not Used.	
A3R235		RESISTOR, VARIABLE, COMPOSITION: 50k ohms ±30%, 1/4w; mfr 28480, P/N 2100-2002.	5-12
A3R236		RESISTOR: MIL type RN60C2212F.	5-12
A3R300		Not Used.	
A3R301		RESISTOR: Same as A3R103.	5-12
A3R302		RESISTOR: Same as A3A1R221.	5-12
A3R303		RESISTOR: Same as A1A3R202.	5-12
A3R304		RESISTOR: Same as A1A1R318.	5-12
A3R305		RESISTOR: Same as A1A1R318.	5-12
A3R306 to A3R312		Not Used.	
A3R313		RESISTOR: Same as A3R121.	5-12
A3R400 to A3R419		Not Used.	
A3R420		RESISTOR: Same as A3R235.	5-12
A3R421		RESISTOR: Same as A3R236.	5-12
A3R422 to A3R470		Not Used.	
A3R471		RESISTOR, VARIABLE, WIRE WOUND: 50k ohms ±3%, 10 turn, 0.1% Lin, 2w; mfr 80294, P/N 3500S42-503.	5-12
A3R500 to A3R519		Not Used.	
A3R520		RESISTOR: MIL type RN60C1202B.	5-12
A3R521 to A3R523		Not Used.	

TABLE 6-1. (Continued)

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG. NO.
A3R524		RESISTOR: Same as A1A1R125.	5-12
A3R525		RESISTOR: Same as A2R354.	5-12
A3S100		Not Used.	
A3S101		SWITCH, LEVER: 1-section, 4-position, non-shorting; mfr 28480, P/N 3100-1341.	5-12
A3S102		SWITCH, LEVER: 1-section, 4-position, non-shortning; mfr 28480, P/N 3100-1356.	5-12
A3S103		SWITCH, LEVER: 1-section, 3-position, non-shorting; mfr 28480, P/N 3100-1342.	5-12
A3S104		SWITCH, LEVER: 1-section, 3-position, non-shorting; mfr 28480, P/N 3100-1343.	5-12
A3S200		Not Used.	
A3S201		SWITCH, PUSHBUTTON: SPST, normally open; mfr 81073, P/N 40YY2015-1.	5-12
A3S300		Not Used.	
A3S301		SWITCH, LEVER: 1-section, 4-position, non-shorting; mfr 28480, P/N 3100-1347.	5-12
A3S302		SWITCH: Same as A3S102.	5-12
A3S303		SWITCH: Same as A3S103.	5-12
A4		COVER ASSEMBLY: MIL type CW-946/USM-281; mfr 28480, P/N 10164A.	1-1
		(Following parts supplied with cover assembly)	
		ADAPTER, CONNECTOR: BNC to TEE, Type UG-274 B/U with nontarnish finish; mfr 95712, P/N 3424-3.	1-1
		ADAPTER, CONNECTOR: BNC male to UHF female, Type UG-255/U with nontarnish finish; mfr 95712, P/N 30429-2.	1-1
		ADAPTER, CONNECTOR: BNC female to UHF male, type UG-273/U with nontarnish finish; mfr 95712, P/N 470-2.	1-1
		ADAPTER, CONNECTOR: MIL type UG-1035U.	1-1
		FUSE, SLOW BLOW: 3AG, 230V, 0.6 amp; mfr 75915, P/N 313-600.	1-1
		PROBE ASSEMBLY: (Red) 10.1 divider probe with 3-ft. coaxial cable; mfr 28480, P/N 10003-62101.	1-1
		PROBE ASSEMBLY: (Black) 10.1 divider probe with 3-ft. coaxial cable; mfr 28480, P/N 10003-62102.	1-1
		ADAPTER, PROBE: Pincer Jaw; mfr 28480, P/N 5060-0417.	1-1
		ADAPTER, PROBE: Pin tip; mfr 28480, P/N 5060-0418.	1-1
		CABLE ASSEMBLY: 8-ft coaxial cable with BNC connectors on both ends; mfr 28480, P/N 10165-61602.	1-1

TABLE 6-2. LIST OF MANUFACTURERS

MFR CODE	NAME	ADDRESS
00213	Sage Electronics Corp.	Rochester, N.Y.
00853	Sangamo Electric Co., Pickens Div.	Pickens, S.C.
01121	Allen Bradley Co.	Milwaukee, Wis.
01281	TRW Semiconductors, Inc.	Lawndale, Calif. 90260
10295	Texas Instruments, Inc., Transistor Products Div.	Dallas, Texas 75231
02114	Ferrocube Corp. of America	Saugerties, N.Y.
02660	Amphenol Corp.	Broadview, Ill. 60153
03877	Transitron Electronic Corp.	Wakefield, Mass.
03888	Pyrofilm Resistor Co., Inc.	Cedar Knolls, N.J. 07927
04713	Motorola, Semiconductor Products, Inc.	Phoenix, Arizona 85008
05397	Union Carbide Corp., Linde Division	Cleveland, Ohio 45246
06090	Raychem Corp.	Redwood City, Calif. 94063
07263	Fairchild Camera & Inst. Corp., Semiconductor Div.	Mountain View, Calif.
08717	Sloan Company	Sun Valley, Calif. 91353
09353	C & K Components, Inc.	Newton, Mass. 02158
14655	Cornell-Dubilier Electric Corp.	Newark, N.J.
14674	Corning Glass Works	Corning, N.Y. 16701
14830	Micro State Electronics Corp.	Murray Hill, N.J.
19701	Electra Mfg. Co.	Independence, Kans. 67301
24455	General Electric, Lamp Div.	Nela Park, Cleveland, Ohio
28480	Hewlett Packard Co.	Palo Alto, Calif. 94304
56289	Sprague Electric Co.	North Adams, Mass.
71400	Bussmann Mfg. Division of McGraw-Edison Co.	St. Louis, Mo.
71590	Centralab, Div. of Globe Union, Inc.	Milwaukee, Wis.
71707	Coto Coil Co., Inc.	Providence, R.I.
71785	Cinch Mfg. Co., Howard B. Jones Div.	Chicago, Ill.
72825	Eby, Hugh H., Inc.	Philadelphia, Pa.
72982	Erie Technological Products, Inc.	Erie, Pa.
73138	Beckman Instruments, Inc., Helipot Div.	Fullerton, Calif. 92634
74276	Signalite, Inc.	Neptune, N.J. 07753
75042	IRC, Inc.	Philadelphia, Pa. 19108
75915	Littlefuse, Inc.	Des Plaines, Ill. 60016
79727	Continental-Wirt Electronics Corp.	Philadelphia, Pa.
80294	Bourns, Inc.	Riverside, Calif. 92506
81073	Grayhill, Inc.	LaGrange, Ill.
82142	Jeffers Electronics Div. of Speer Carbon Co.	DuBois, Pa.
82389	Switchcraft, Inc.	Chicago, Ill. 60630
83330	Smith, Herman H., Inc.	Brooklyn, N.Y. 11207
95265	National Coil Company	Sheridan, Wyo.
95348	Gordos Corp.	Bloomfield, N.J. 07003
95712	Dage Electric Co., Inc.	Franklin, Ind.
98291	Sealectro Corp.	Mamaroneck, N.Y. 10544
99800	Delevan Electronics Corp.	East Aurora, N.Y.
99848	Wilco Corp.	Indianapolis, Ind.

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